GUIDELINES FOR COLLECTING, ANALYZING, AND INTERPRETING GROUND WATER DATA FOR MINERAL DEVELOPMENT

ENCL. 1

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
WASHINGTON, D.C. 20240

IN REPLY REFER TO:

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To: All State Directors

From: Director

Subject: Guidelines for Collecting, Analyzing, and Interpreting Ground Water Data for Mineral Development

DD 1/31/85

Enclosed are Draft Guidelines for Collecting, Analyzing, and Interpreting Ground Water Data for Mineral Development sites. These guidelines are intended to assist non-hydrologists at the resource area level in utilizing existing water resources data to evaluate mineral development sites. Please review them for both their technical content and utility. We have taken the liberty of forwarding copies to the District Offices.

Please return your comments to Sherol Smith (WO 690), (FTS 653-2263) by January 31, 1985.

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Assistant Director, Mineral Resources and Mining Law

1 Enclosure:
Encl. 1 - Draft Guidelines for Collecting, Analyzing, and Interpreting Ground Water Data for Mineral Development (91 pp)

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I. INTRODUCTION

A. Purpose

The purpose of this document is to provide technical guidance within the framework of the BLM Planning system for the identification and use of existing ground water data for lands involved with energy and mineral development or hazardous materials issues. The primary authority for the management of ground water lies with the individual States and their designated agencies. This guidance is issued with the purpose of expediting and streamlining the leasing of energy and mineral resources on Public Lands. This may be accomplished through increased awareness of basic ground water interpretive techniques, and improved coordination of State, Federal, and private ground water collection programs, and BLM activities.

These guidelines augment the Ground Water Manual (7230).

The objectives of these ground water/mineral development guidelines are to:

* Identify the BLM role and BLM's authorities in relation to states authorities, and identify the most effective means of cooperation concerning ground water resources affected by energy and minerals/hazardous materials activities on BLM lands;

* Develop technical guidelines for the collection, analysis, and interpretation of existing ground water information.

* Provide guidance to facilitate the prediction of potential effects on ground water resources due to mineral development or hazardous materials management.

B. Scope

Because of the nature of ground water and the uses placed upon it, both management decisions and protection requirements are especially important if any of the following conditions exist in an area:

* A significant ground water basin or aquifer system exists.

* A principal or sole-source aquifer therein has been designated or is being considered for designation by a state or EPA program.

* Hazardous or toxic substances entering the ground water system (e.g., through municipal land fills, surface spills, or designated hazardous waste sites) may potentially affect water users.

Ground water resources are assessed in support of the following BLM programs. BLM's Inventory Coordination System (Manual 1734 .21-.24) should be consulted before starting such investigations related to energy and minerals.

Ground Water Inventory and Analysis for Bureauwide Regional Programs or Special Studies - Ground water data collected Bureauwide or regionally will often focus on a single ground water issue or concern; for example, collection and analysis of data for a regional mineral ES (coal, oil shale); inventory and monitoring to assist the USGS in regional aquifer studies or investigations of potentially hazardous waste sites. Such broad studies require interagency, Federal, and state coordination to ensure complete and economical coverage. Federal and state cooperative data collection programs exist in most states and may provide data for land management decisions involving ground water issues. OMB Circular A-67 (Aug. 28, 1964) requires such coordination.

Ground Water Inventory for Multiple Use Planning - Ground water inventory will be based on known or anticipated planning issues. The level of detailis dictated by the nature of the issues and level of acceptable risk.

Ground Water Inventory for Activity Planning - Ground water data in support of activity planning should build on existing data banks supplemented if necessary by collection of new data from the field.

The assembly and analysis of ground water data will be consistent with the management oriented issue process for public lands. However, because of relatively recent concern over ground water and the near total lack of emphasis placed on it in most inventory and monitoring efforts on public lands, energy and mineral issues involving ground water may not be readily identifiable.

C. Procedure

BLM recognizes the following procedure in the ground water assessment process:

1. Consider the General Inventory Policy and Criteria contained in the Manual 1734, Inventory Coordination Systems.

2. Define the Study Objectives to avoid needless data collection.

3. Consider the Known Energy/Minerals Ground Water Issues related to mining or hazardous materials. Representative examples include (a) leaching of water through spoil piles downward into the ground water systems, (b) migration of toxic materials associated with mining that have been disposed of on the surface, (c) water-rock interaction when pH is changed due to contact with certain minerals or oxidation products, and (d) disruption of aquifers, especially sole-source aquifers as defined in Section 1424(e) of the Safe Drinking Water Act.

4. Analyze the Adequacy of Existing Ground Water Data for Bureauwide, regional, or special programs, multiple-use planning, activity planning or monitoring. Document the presence or absence of pertinent ground water data. Consider the date of collection and the relative utility of the ground water data for current policies and issues.

5. Recommend Inventory Needs and submit these as part of the geology program proposal. Because changes in ground water quality and quantity often are detected only after it is too late to manage them, awareness of probable trends is essential to the planning process.

D. Organization

Decisions affecting lands containing potential energy and mineral resources must be based upon adequate levels of information to ensure that the merits and drawbacks of proposed actions can be examined with a suitable level of confidence. Various levels of decisions will require differing levels of information, the most complex often requiring the acquisition of costly new data to supplement the existing information base.

Two levels of investigative methodology have been developed to characterize the intensity of a particular ground water inventory. The level of inventory for specific studies shall be determined by the (1) risk the decision maker is willing to accept and (2) time and fiscal restraints. (I) Reconnaissance Level of Knowledge and (II) Intensive Level of Knowledge are concerned with the collection, analysis, and interpretation of currently existing geological, hydrogeological, and water resources data. A brief description of the methodologies for these levels is given below. These will be augmented and redefined over time as familiarity and expertise with ground water and hazardous materials issues increase.

Section II of this report summarizes the legislation pertinent to Ground Water. Sections III and IV describe in detail the methodology for acquisition, analysis, and interpretation of Level I and II information. The Appendix includes a list of suggested data bases and references. At this point it is necessary to emphasize that Level I and II methodologies are intended to be guidelines for issue driven data collection.

1. Level I - Reconnaissance Level of Knowledge

Generally corresponding to the Level I inventory in the 1734 Manual Inventory Coordinating System, a Reconnaissance Investigation is a relatively low cost inventory of a large area and requires no field verification. It is applicable to broad studies of aquifer basins of district or statewide scope. Information from this level provides insight into the design of more advanced levels of investigation. A Level I inventory would suffice when the proposed land use has no significant long term effect on the quality or quantity of useable ground water. The land manager must ascertain whether the ultimate land use decision can be made with available information or requires more data. The issues unique to the area must then be considered.

Level I is characterized by these standard investigative techniques:

1. Review geologic and ground water literature on regional hydrogeologic conditions.

2. Augment this data where necessary with records from USGS WATSTORE data base (Ground Water Site Inventory file) or state records. Collect well records primarily from literature.

3. Prepare a base map of the area.

4. Identify and describe aquifer characteristics.

5. Describe the water quality for each of the various geologic units.

6. Estimate the general potential for ground water development in the study area.

7. Identify gaps or anomalies in the data which may require further research.

2. Level II Intensive Level of Knowledge

This generally corresponds to the Level II inventory in the 1734 Manual. An investigation at the Intensive Level provides more detailed information to fill data gaps identified during the Reconnaissance Level Investigation. The resulting document should utilize a comprehensive literature source list and provide all available data required to make decisions regarding land use, as well as some potential site specific impacts to the ground water system. Depending on the complexity of the issues, some site evaluations may require investigation beyond Level II which will entail new data collection. Generally a Level II inventory will suffice when the proposed action may have significant medium or long term effects on the quality or quantity of ground water but no permanent or detrimental effect. For hazardous waste sites, the minimum acceptable study will be at Level II.

Level II is characterized by the following investigative procedures:

1. Collect drillers' logs and well construction details of as many wells as possible. (Level I does not call for exhaustive searches to locate these kinds of data, only those that are easily obtainable.)

2. Collect and analyze data from representative aquifer tests.

3. Prepare water level contour maps and combine with sufficient data on geology and hydrology to develop an understanding of the hydrologic boundary conditions in the area.

4. Analyze water quality data from the viewpoint of mineral composition of the aquifers and in view of potential pollution sources (e.g., fertilizer use in agricultural areas can produce high arsenic levels).

5. Make integrated analysis of stream flow and ground water records.

6. Analyze and evaluate data on those stresses affecting the ground water system. Identify existing and potential problems and provide solutions where possible.

II LEGISLATION PERTAINING TO GROUND WATER RESOURCES

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Introduction

It is the policy of Bureau of Land Management (BLM) to comply with State requirements regarding the use and protection of ground water and to assist the States in their management of that resource. The role and responsibilities of Federal laws and regulations. The pertinent aspects of these laws and regulations are discussed in this overview.

1. The Federal Land Policy and Management Act of 1976 (FLPMA), P.L. 95-87, (91 Stat 445, Aug 3, 1977)

There are four sections in FLPMA where authorization is given to conduct investigations on resources (such as ground water) involved with public lands. One section (102.(a)(8)) mentions water resources as a value needing protection, however, none of the sections mention ground water specifically, i.e.:

> Sec. 102.(a)2: "the national interest will be best realized if the public lands and their resources are periodically and systemtically invetoried and their present and future use is protected...";
>
> Sec. 102.(a)(8): "the public lands be managed in a manner that will protect." ..."water resources";
>
> Sec. 201(a): "The Secretary shall prepare and maintain on a continuing basis an inventory of all public lands and their resources";
>
> Sec. 603(a): "The review required by this subsection shall be conducted in accordance with the procedure specified in Section 3(d) of the Wilderness Act."

BLM Wilderness Management Policy formulated in September 1981 and based on the Wilderness Act, states that:

> "111.F Water Resources Management" "The BLM's conclusions and recommendations in connection with proposals for new water resources developments will be based upon comprehensive, factual information developed by an environmental analysis..." "Maintaining or enhancing water quality is of high priority in managing the wilderness resource."

Although the ground water phase of water resources is not mentioned specifically, the interrelationships between surface and ground water resources are such that the terms water resources or water quality pertain to both.

2. Clean Water Acts (CWA), P.L. 92-500, As Amended by P.L. 95-217, P.L. 95-576, P.L. 96-483, and P.L. 97-117; 33 USG 125. et seq.

The objective of the CWA are the restoration and maintenance of the chemical, physical and biological integrity of the nation's waters. While the Act emphasizes the need to protect the quality of "navigible" or surface waters and provides numerous Federally enforceable provisions to do so, the Act also clearly indicates protection of ground water quality. To some extent the emphasis on regulation of discharges to surface waters has resulted in discharge to and pollution of ground water which is not subject to Federal regulation and protection under this Act.

Under the CWA, authority to protect ground water is vested the States. Specifically Section 208b.2 requires that individual States develop processes to identify and control:

* surface and underground mining-associated pollution of ground and surface water;

* salt water intrusion into ground water aquifers or surface waters;

* the disposition of residual wastes which could adversely affect ground or surface water quality; and

* disposal of pollutants on land or in subsurface excavations to protect ground or surface water quality.

The Federal roles under the CWA in regard to ground water quality are limited to providing guidance and assistance to State and local governments management of the resource and to complying with the State and local requirements and standards for the protection of the resource. The act provides for Federal financial assistance for State planning and management of the resource under Sections 208 and 106 of the Act respectively. Section 313 of the Act waivers Federal immunity in regard to compliance with valid requirements of State and local government for protection of water quality including that of ground water and requires Federal agencies to comply to the same extent as any nongovernmental entity.

3. Safe Drinking Water Act (P.L. 93-523), As Amended by P.L. 95-190, 42 USC 300 et seq.

The purpose of the Safe Drinking Water Act (SDWA), as amended, is to protect the public health and welfare by assuring that drinking water provided by public water systems be of adequate quality for human use. To accomplish this, the Act provides for:

* Establishment of primary national drinking water regulations setting forth mandatory maximum contaminant levels in drinking water supplied by public water systems.

* Establishment of secondary national drinking water regulations for public water systems. These regulations are discretionary and aimed at prompting public welfare.

* Protection of the quality of these aquifers which serve as the sole principal source of drinking water for an area and which, if contaminated, would create a significant hazard of public health.

* Protection of underground sources of drinking water from contamination by underground injection of pollutants.

The SDWA provides for, and encourages, delegation of its authorities to the States which would assume primary responsibility for enforcing the requirements of the Act. Only in the event that a State failed to assume the responsibility would the enforcement be an EPA responsibility.

Under the provisions of Section 1447 (a) of the Act, BLM is required to comply with both the substantive and procedural requirements of the Act. Specifically, Section 1447 directs that...

> "(a) Each Federal agency (1) having jurisdiction over any federally owned or maintained public water system or (2) engaged in any activity resulting, or which may result in, underground injection which endangers drinking water (within the meeting of section 1421(d)(2)) shall be subject to and comply with, all Federal, State, and local requirements, administrative authorities, and process and sanctions respecting the provision of safe drinking water and respecting any underground injection program in the same manner, and to the same extent, as any non-governmental entity."

Under the provisions of the Act, BLM therefore is not responsible for primary enforcement of the requirements of the Act, but rather is regulated by those provisions. Thus BLM's role is to assist the States in their efforts to protect the quality of ground water which has present or potential use as an underground source of drinking water.

Section 1424(e) of the Act establishes a procedure which enables the EPA, either on its own initiative or on the basis of public petition, to designate an aquifer that has been determined to be the sole or principal drinking water source for an area as a "sole-source aquifer." The sole-source designation means no federally financially assisted project may be constructed on a site that would lead to contamination of the aquifer and the subsequent creation of "a significant hazard to public health."

Other ground water related provisions are set forth in Sec. 1421, Underground Injection Control (UIC). The objective of these provisions is to prevent endangerment of drinking water sources by subsurface emplacement of fluids through well injection. States have the authority to implement the UIC program.

Applicability of the State UIC regulations to BLM as well as other Federal agencies is mandated in sec. 1421(b)(1)(D). This section directs that the state programs shall apply..."to underground injections by Federal Agencies, and to underground injections by any other person whether or not occurring on property owned or leased by the United.

In authorizing underground injection on Federal lands, BLM will require the injector to obtain a UIC permit from the State or EPA as appropriate and will supplement the conditions set forth in that permit as may be required to protect natural resources administered by BLM.

4. Resource Conservation and Recovery Act (P.L. 94-580), As Amended by the Solid Waste Disposal Act Amendments of 1980 (P.L. 96-482) USC 6901 et seq.

The Resource Conservation and Recovery Act (RCRA), as amended, provides Federal legislation and direction concerning the management of solid wastes, including hazardous wastes that may significantly contribute to serious illness or that may impose a hazard to human health or the environment when improperly managed.

The Act also places specific requirements on the secretary of Interior regarding coal mining and its regulation under the Surface Mining Control and Reclamation Act (SCMCRA). Section 100 (c) of RCRA states that:

> "(2) The Secretary of the Interior shall have exclusive responsibility for carrying out any requirement of subtitle C of this Act with respect to coal mining wastes or overburden for which a surface coal mining and reclamation permit is issued or approved under the Surface Mining Control and Reclamation Act of 1977. The Secretary shall, with the concurrence of the Administrator, promulgate such regulations as may be necessary to carry out the purposes of this subsection and shall integrate such regulations with regulations promulgated under (SMCRA)"

Elsewhere, the act waives the development and enforcement of regulations addressing mining wastes, pending completion of the study by EPA. Thus, no action has been taken by the Secretary to meet this requirement pending release of the mandated study.

The various specific references to underground waters clearly establish this Act as a major piece of legislation protecting ground water quality.

Section 1002, which states the Act's objectives, is prefaced by a Congressional observation that "open dumping is particularly harmful to health, contaminates drinking water from underground and surface supplies and pollutes the air and the land."

Section 1004 defines the term "disposal" as the "discharge, deposit, injection, dumping, spilling, leaking or placing of any solid waste or hazardous waste or any constituent there of that may enter the environment or be admitted to the air or discharged into any water, including ground water."

The Act emphasizes the primary role of the States in managing both conventional solid wastes and hazardous wastes. The legislation provided a Federal support role with minimal enforcement and regulatory process in regard to conventional solid wastes. Actual regulation and enforcement of solid-nonhazardous wastes was left to the individual States who were to follow board guidelines established at the Federal level. The Federal role in hazardous waste management is far more extensive and forceful. While the States are encouraged to assume responsibility for the program, they may not do so without first satisfying rigorous Federal requirements, and even then would be subject to Federal oversight and review, particularly insofar as the mandated waste disposal permits are concerned

RCRA provides for the permitting of storage, treatment and disposal facilities and a manifest system, to enable EPA to track the movement of hazardous wastes from generation to disposal site.

The BLM is subject to, and must comply with, all Federal, State, interstate, and local requirements, both substantive and procedural (including any requirements for permits, reporting, or any provisions for injunctive relief and such sanctions as may be imposed by a court to enforce such relief), respecting control and abatement of solid or hazardous waste disposal in the same manner and to the same extent as any person is subject to such requirements. This waiver of sovereign immunity extends to Federal employees.

Furthermore, BLM is required, by Sec. 6004 of the Act, to ensure compliance with both Federally issued guidelines for disposal of solid waste and with the purposes of the Act in the disposal of such waste. This specifically includes "protection of the quality of ground waters and surface waters from leachate."

Unlike much other Federal legislation, RCRA provides for joint and several liability of both owners and operators of a waste storage, treatment or disposal site regulated under the hazardous waste management system. Thus, it is BLM's duty as "owner" to ensure compliance with RCRA requirements for a non-BLM-operated disposal facility authorized on the public lands.

It is important to note that state or local governments may add additional duties and responsibilities on BLM for protection of ground water from pollution by disposal of solid of hazardous wastes on the public lands, providing only that such requirement is germane, duly adopted and generally applicable. An example of such a situation is the State of California's recent decision to hold owners of solid (i.e., nonhazardous) waste disposal sites co-liable with the operators of such sites. It is in the States's position that this ruling applies to agencies of Federal, State and local government as well as private individuals. Under this rule, BLM is coresponsible for design, operation, closure and post closure monitoring, and for any future liabilities arising from such responsibilities.

5. Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). P.L.96-510, 94 Stat 2767 et seq. (Dec. 11, 1980)

This Act, popularly known as the "Superfund" provides additional authority of the control of hazardous substances which have been or might be released into the environment. This legislation differs from RCRA in that its authorities concern accidental releases of hazardous substances which are not necessarily waste materials and hazardous waste releases, including potential release, from abandoned or inactive facility sites. The Act provided for the establishment of a tax-supported Hazardous Substance Response Trust Fund (the "Superfund") to pay the costs of response actions, accidental releases and for cleanup of abandoned or inactive sites, if responsibility for paying such costs cannot be assigned elsewhere. At this time Federal agencies may utilize the Superfund for reimbursement of only very limited types of activity. To all intents and purposes, Federal agencies must seek their own funding for compliance and cleanup on Federal lands through the appropriations process.

A second fund--the Post-Closure Liability Trust Fund--is established by CERCLA. This fund is supported by a $2.31 tax on each day weight ton of hazardous waste received at a disposal site for permanent disposal. The monies will be utilized by the Federal government in paying cost associated with its assumption of post-closure liabilities. This is particularly important since it provides a further long-term protection to ground water quality. The applicability of this fund to Federal lands is not known at this time. At this time it is highly possible that these funds would not be available for use on Federal lands.

6. TOXIC SUBSTANCES CONTROL ACT (TOSCA)

This act protects human health and environment by requiring testing and use restrictions for chemical substances which may present an "unreasonable risk of injury to health or the environment." The stated intent of the act is to carry out regulatory efforts with a minimum inpediment of economic efforts and innovation.

TOSCA was designed to be the umbrella act for all other legislation which addresses toxic substances impacts on the environment or human health. The Act addresses testing manufacture and processing, R&D, impacts and provides for support of state regulatory programs. TOSCA sets forth requirements governing disclosure of data, prohibited acts, judicial review, citizen civil actions and petitions, employee protection, and provide for special studies and development of test methods.

The major burden of the act is placed on manufacturers, processors, and distributors of potentially toxic substances. However, uses of such substances and therefore users, may also be regulated. The Act also provides for the regulation of the disposal of toxic substances produced under its jurisidiction. In EPA's current interpretation of the Act, banning or restriction of use, disposal, or storage could be applied where ground water contamination by potentially threating chemicals has occured or may be expected to occur.

The act requires that the Administrator be notified in advance regarding the manufacture of a new chemical or the processing or distribution of chemical for a new use. Based on the information received, or lack there of, the administrator is impowered to prohibit or limit manufacture, processing, or distribution to prevent an "unreasonable risk." The actions the administrator takes to address an established unreasonable risk must apply one or more of the requirements set forth in section 6. These requirements address a range of options including the prohibition manufacture, processing or distribution of the substance, prohibition or limiting of specific uses, prohibiting or regulating disposal, monitoring and testing requirements, and requiring warning notices.

Section 4 addresses the development of testing requirements and the minimum chemical characteristic considerations requiring testing. Under this section substances exhibiting such characteristics as perisistence, acute toxicity, subacute toxicity, chronic toxicity or other such characteristics is required to be tested. The act specifies that testing shall address such potential impacts as:"Carcinogensis, Mutagenesis, Teratogenisis, behavioral disorders, cumulative or synergistic effects, and any other effect which may present an ureasonable risk...".

Refusal to comply with rules promulagated under the act; commercial use of substances or mixtures which are known to be manufactured or processed in violation if the act; refusal to maintain records, submit reparts or permit access to records as required; and refusal to permit entry or inspection are declared unlawful acts by Sec. 15. Section 16, on the other hand, provides civil penalties up $25,000 per day for the duration of the violations with additional criminal penalties of $25,000 per day and/or imprisonment for 1 year when warrented. Criminal and civil penalties may be applied consecutively.

Section 20 addresses civil suits. It permits anyone to file civil suits against anybody, including governmental bodies with in the limits of the eleventh Constitutional Amendment.

As in the case of RCRA, the sovereign immunity of Federal agencies and their employees is waived. The agencies, and employees, are required to comply with applicable Federal, State and local requirements to the same extent as any other person. Furthermore, as in the case of RCRA, BLM is considered to be the owner of any inactive or abandoned hazardous waste storage or disposal site on the lands under its jurisdiction. As such it may be jointly and severally liable with the operator for all damages and remedial costs associated with such sites.

The protection of ground water quality from pollution by leachates resulting from accidental releases or from abandoned or inactive waste disposal sites is a major area of concern under CERCLA. Monies from the Superfund are available (off Federal lands) for ground water investigation, protection and cleanup. A similar situation exists as concerns the Post-Closure Trust Fund.

7. Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) regulates the manufactures, distribution use, and disposal of pesticides. The primary emphasis of the act is on the labeling of pesticides and the registration of pesticides for specific uses.

The law provides for the regulation of the use of pesticides allowing a general use classification and providing for restricted use where appropriate. In the case of restricted use pesticides, users and applicators must be certified. A restricted use pesticide must be applied by an applicator who is certified according to the requirements of this act and/or the appropriate state.

In EPA's current interpretation of the Act, use restrictions could be applied where ground water contamination by pesticides has occurred or may be expected to occur.

The act also established requirements for the regulation of pesticide establishments, established general requirements for record keeping, provides for stop sale and removal/seizure of pesticides, defines unlawful acts and provides both civil and criminal penalties.

The exemption for federal and state governments under the 11th amendment of the constitution, however, are not waived in this act. Civil penalties of $1000 to $3000 per day are provided by section 14 for violation of the act. In addition, the section provides for criminal penalties of $1000 and/or 30 days in jail to $25,000 and/on one year in jail. Unauthorized disclosure of confidential material carries a $10,000 fine and/or up to 3 years in jail.

Federal or state agencies may be exempted from any requirements of this act of the Administrator of EPA only when emergency conditions are determined to exist.

8. Surface Mining Control and Reclamation Act (SMCRA) (P.L. 95-87, 91 Stat. 445, 30 U.S.C. 1201 et seq. (Aug. 3, 1977)

The intent of the Surface Mining Control and Reclamation Act is to prevent "imminent danger to the health and safety of the public" and "significant, imminent environmental harm to land, air or water resources," that might be caused by both surface and underground mining operations.

The law requires the completion of hydrogeologic studies prior to the covering or burial of acid-forming and toxic forming waste materials, as well as when any mine is to be filled with any type of waste material. Also, the mine operator must demonstrate that the activity will only minimally disturb the hydrologic balance of the area. Further, if the mining operation contaminates, diminishes or interrupts the ground water or surface water supply of a adjacent land owner, the mining company must replace the water supply.

Additional requirements by the secretary regarding toxic forming waste materials may result from SMCRA's integration with RCRA which is discussed under RCRA. No action had been taken by October 1984 pending the outcome of studies mandated by RCRA.

Although the SMCRA is administered by the Office of Surface Mining, BLM is involved with the implementation of that Act on Federal lands, and thus with related ground water considerations in several ways. Basically BLM's ground water responsibilities involve evaluation of the probable hydrologic and water quality effects of mining and reclamation practices upon the ground water system. Specific citations concerning these responsibilities occur in Secs. 507(b)(11), (14), and (15); Secs. 508(a)(12) and (13); Sec. 510(b)(5); Sec. 515(b)(10) and (14); and, Sec. 522(a)(3)(c).

9. Coal Management Regulations (Amendments to Bureau of Land Management Coal Program Regulations), 43 CFR, Part 3400, (47 Fed. Reg. 33114, July 30, 1982 - eff. Aug. 30, 1982)

Coal regulations were published under the authority of the Mineral Leasing Act of 1920 as amended and supplemented; the Federal Land Policy and Management Act of 1976; the Surface Mining Control and Reclamation Act of 1977; and the Multiple Mineral Development Act.

10. Oil Shale Management (BLM Regulations): Procedures for the Management of Federally Owned Oil Shale Resources 43 CFR 3900

The Regional Oil Shale Team has specific responsibilities (3900.3(b)) for recommending to the State Director which investigations should be conducted on Federally owned oil shale resource. These recommendations are developed at public team meetings held for the purpose of:

> Providing recommendations for the Bureau's land use planning and environmental impact analysis, including "...analyses and alternatives to be analyzed in environmental impact documents."

The Regional Oil Shale Team is to submit a written report to the Director which "shall be developed considering the following criteria: "..."4. Environmental..."impacts identified during land use planning and associated with environmental impact analysis." Ground water is present in, above and below the oil bearing shale layers and is impacted during mining or in situ retorting of oil shale.

Ground water considerations are an integral part of the analyses involved prior to competitive leasing (Subpart 3420), preference right leases (Subpart 3430) and during environmental considerations (Subpart 3460). As in the case of SMCRA, the effect of proposed mining and reclamation practices must be evaluated in terms of their effect on ground water to assure that adverse effects, if any, would be within tolerable limits.

11. UMTRCA

The Uranuim Mill Tailings Radiation Control Act (UMTRCA) holds that Mill tailings at active and inactive uranium mill operations may be potentially significant public health hazards. Futher the act states that every reasonable effort should be made to stabilize control, and dispose of such tailings in an environmentally sound and safe manner, preventing or minimizing radon diffusion and other environmental hazards. The act states as its purposes the provision of: 1) a program of assessment and remedial action at such sites, and 2) a program to regulate mill tailings during processing at active mills, through and after termination of the operation.

TITLE I

This title addresses remedial action at abandoned sites. A list of processing sites at specific locations are required to be designated. IT 2150 requires the inclusion of any other contaminated real property or improvements in the vicinity related to the site. Cooperation and cooperative agreements with states and Indian tribes; lands acquisition for public health protection and waste disposal; other subsurface mineral rights; and other pertinent factors are addressed.

When remedial action is carried out, the technology used must permit compliance with the general standards promulgated by the Administrator of EPA including ground water. The secretary of Energy is responsible for assuring such techology is used.

Violation of the provisions of Title I or any cooperative agreement entered into pursuant to this title is subject to a maximum civil penalty of $1000 for each day of violation.

TITLE II

This title addresses the handling and disposal of waste materials and the licensing of those who handle such materials for active sites. It requires licensees to comply with decontamination, decomissioning and reclamation standards prescribed by the Commission. It also requires the Commission assure that licensees will maintain property and materials "... in such a manner as will protect the public health safety and the environment". When appropriate, the transfer of land and interests affected by the license to the Federal or State government, prior to terminating the license, to protect the public health, welfare and the environment is authorized. In addition, "... pursuant to a license, rule or order ..." requirements "... to under take such monitoring, maintainance, and emergency measures as are necessary to protect the public health and safety..." are authorized. The Commission is given the authority "... to require the Secretary or other Federal agency or State having custody of such lands and interest "... to undertake such monitoring" (sec 202). The act gives the Commission authority to establish standards and instructions regarding: 1) adequate bonding or surety; 2) long term maintainence and monitoring of sites; and 3) financial arrangements by the licensees for long term maintainence and monitoring prior to termination (sec 203).

Section 204 of the Act provide for cooperation with States on the issues of active sites and their by-product material and the development of State agreements. Such cooperation and agreements includes "... compliance with standards which shall be adopted by the state for the protection of public health, safety, and the environment...", provided they are equivalent or more stringent than standards promulgated by the Environmental Protection Agency (EPA). Further, the established state standards will provide for public comment, written environmental analysis, an assessment of impacts including ground water impacts, etc.

The authorities respecting by product material discussed in section 205, requires the Commission to insure the management of such material is conducted is such manner as to protect the public health, safety, and the environment in conformance with the applicable general standards promutgated by the EPA; and are comparable to requirements under the solid waste proposal act. Section 275 (b) (2) states that generally applicable standards promulgated pursuant to this subsection for non-radiological hazards shall provide "... protection of human health and the environment consistent with the standards required under subtitl/ C of the Solid Waste Disposal Act...".

Violation of this title is subject to existing Civil penalties defined under section 234.

12. Nuclear Waste Policy Act

The Act applies to the disposal and storage of high-level radioactive wastes spent fuel, and low level wastes from civilian sources with consideration of disposal of waste from defense activity. The Act has three title headings which address the major areas of concern covered by the Act.

The provisions of the Act apply to "any repository not exclusively used for the disposal of high-level radioactive waste or spent nuclear fuel resulting from atomic energy defense activities research and development activities of the Secretary or both.

The Act has three Titles. Titles I and II contain most of the substantive parts of the Act while Title III contains other miscellaneous provisions related to radioactive waste such as mission plan, a discussion of the nuclear waste fund, alternate financing issues, etc.

Title I Disposal and Storage of High level Radioactive Waste, spent Nuclear full, and Low-level radioactive waste is dedicated to the following purposes:

(1) to establish a schedule for the siting, construction and operation of repositories that will provide a reasonable assurance that the public and the environment will be adequately protected from high level radioactive waste/spent full hazards;

(2) to establish the Federal responsibility, and definite Federal policy, for the disposal of such waste and spent fuel;

(3) to define the relationship between the Federal Government and the State government with respect to the disposal of such waste and spent fuel; and

(4) to establish a Nuclear Waste Fund, composed of payments made by the generators and owners of such waste and spent fuel, that will bear much of the disposal costs. The purposes of Title II - Research, Development, and Demonstration regarding Disposal are:

    (1) to provide direction to the Secretary with respect to the disposal of high-level radioactive waste and spent nuclear fuel;

    (2) to authorize the Secretary, to provide for a focused and integrated high-level radioactive waste and spent nuclear fuel research and development program;

    (3) to provide for an improved cooperative role between the Federal Government and States, affected Indian tribes, and units of general local government in the siting of a test and evaluation facility.

Most of the issues addressed under Title I and II such as siting, cooperation with States and Indian tribes, publish hearings, environmental assessments, waivers of EIS's, required EIS's, land acquisition, etc are addressed in the same or similar manner. The guidance in the two titles tends to be duplicative. Since Title I is the most comprehensive in its coverage of the nuclear waste disposal concerns it is emphasized and related Title II issues may be assumed to be handled in the same manner unless otherwise stated.

Under title I, the guidelines for recommending candidate sites are addressed. Sites nominations must be accompanied by an environmental assessment which includes:

(i) an evaluation by the Secretary as to whether such site is suitable for site characterization under the guidelines;
(ii) an evaluation by the Secretary as to whether such site is suitable for development as a repository under each such guideline that does not require site characterization as a prerequisite;
(iii) an evaluation by the Secretary of the effects of the site characterization activities on the public health and safety and the environment;
(iv) a reasonable comparative evaluation by the Secretary with other sites and locations;
(v) a description of the decision process; and
(vi) an assessment of the regional and local impacts

In addition, the Secretary of Energy is required to use available geophysical, geologic, geochemical hydrologic and other information, and restricts drilling to 6" holes when it is absolutely necessary to drill.

This title and Title II restrict the application of NEPA and define when environmental assessments are required and when EIS's are required. In addition, both titles provide extensive lists of mandatory material be included in EIS's or assessments, such as the one cited above. While the site selection process is exempted from an EIS, the final selection sites forwarded to Congress must be accompanied by an EIS. An EIS is also required for portions of the active construction and development phases for approved sites. This applies both long term storage sites under Title I and Research Sites under Title II.

All site selection recommendations are forwarded to the President who reviews them and renders a decision within specific time frames. The selected sites are forwarded to Congress for final approval by joint resolution.

The site selection process also requires local public hearings to be held for each site under consideration; consultation and cooperative agreements with the affected states or Indian Tribes, and financial assistance to states, tribal, and local governments where appropriate. In addition to these requirements the Act mandates that actions related to the authorization of repositories be expedited; however, EPA is also mandated to develop general standards for the protection of the

environment from radiation and the commission is mandated to develop technical standards compatible to EPA's standards. The expedited actions must comply with these standards.

An interim storage program is instituted for the following purpose:

(1) to provide for the utilization of available spent nuclear fuel pools at the site of each civilian nuclear power reactor and the addition of new spent nuclear fuel storage capacity and
(2) to provide for the establishment of a federally-owned and operated system for the interim storage of spent nuclear fuel, facilities owned by the Federal Government to prevent disruptions in the orderly operation of any civilian nuclear power reactor that cannot reasonably provide adequate spent nuclear fuel storage.

The government is mandated to encourage and expedite effective use of available storage in a manner consistent with:

(1) the protection of the public health and safety, and the environment:
(2) economic considerations;
(3) continued operation of the reactor
(4) any applicable provisions of law; and
(5) the views of the population surrounding such reactor.

When a Federal interim storage site is to hold more than 300 metric tons an EIS must be prepared which includes:

(i) an estimate of the amount of storage capacity available at such site;
(ii) an evaluation as to whether the facilities to be used at such site are suitable for storage
(iii) a description of activities planned by the Secretary with respect to the modification or expansion of the facilities to be used at such site;
(iv) an evaluation of the effects on the public health and safety, and the environment;
(v) a reasonable comparative evaluation of current information site and facilities and other sites and facilities available for storage
(vi) a description of any other sites and facilities that have been considered and
(vii) an assessment of the regional and local impacts of providing such storage capacity at the site including transportation

The Act provided for an interim storage fund which allows the secretary to enter into contracts with civilian owners or generators of spent nuclear fuel; and, places limitations on the use of such site by U.S. Government agencies.

The normal requirements regarding State, tribal and local governments apply. Evaluation criteria are established and Congress reserves override authority on any interim siting decision.

Low level radioactive waste site and their closure is also addressed under Title I. The Commission is required to assure that financial arrangements are made for long-term maintenance or monitoring of such sites. When certain requirements are met the Commission may assume title and custody as such sites.

Title II of the Act addresses the same issues as they relate to research and demonstration sites. However, there are some additional restrictions. For instance, operation of test facility is limited to 5 years.

All Titles of the Act make provision for incorporating judicial review and adjudication into the decision making processes at various points. In addition, full documentation of public input is required for any final recommendation or review.

The Act implies that the Department of Energy has the ultimate authority, control and ownership over all the various sites discussed. However, it is unclear whether this control is permanent or may ultimately revert to BLM with all the potential problems such sites entail. Further, BLM land is not exempt for the site selection process. Therefore, we may be involved in the early decision making process.

13. Executive Order 11514 - Protection and Enhancement of Environmental Quality, Mar. 5, 1970

Ground water issues are inferred in the policy statement:

"Section 1. Policy. The Federal Government shall provide leadership in protecting and enhancing the quality of the Nation's environment to sustain and enrich human life. Federal agencies shall initiate measures needed to direct their policies, plans and programs so as to meet national environmental goals."

Section 2. Responsibilities of Federal Agencies:

The authority or responsibility to conduct ground water investigations is ordered indirectly through general directives in this section. Federal agencies shall:

> (a) Monitor, evaluate, and control on a continuing basis their agencies activities so as to protect and enhance the quality of the environment. Such activities shall include those directed to controlling pollution and enhancing the environment and those designed to accomplish others program objectives which may affect the quality of the environment. Agencies shall develop programs and measure to protect and enhance environmental quality and shall assess progress in meeting the specific objectives of such activities. Heads of agencies shall consult with appropriate Federal, State and local agencies in carrying out their activities as they affect the quality of the environment."

(b) Engage in exchange of data and research results, and cooperate with agencies of other governments to foster the purpose of the Act.

14. EXECUTIVE ORDERS 11735 & 12418

Executive Order 11735 implements the requirements of Section 311 of the Federal Water Pollution Control Act, later called the Clean Water Act. It establishes the executives authorities and procedures for addressing oil and hazardous wastes spills affecting navigable waters of the U.S. or impacting water quality standards. The definitions used traditionally include groundwater when considering potential impacts. The National Contingency Plan and emergency task forces are established by this E.O. and all federal agencies with appropriate expertise are obligated to provide assistance.

Executive Order 12418 transfers the functions relating to the financial responsibility of vessels to the Coast Guard and provides oversight authority to EPA.

15. EXECUTIVE ORDER 11990

This Executive Order directs all agencies to provide leadership and take action to minimize the destruction, loss or degradation of wetlands in keeping with NEPA. It covers of aspects of Federal activities affecting wetlands including land management, facilities development and regulation on licensing activity. The agencies are requested to minimize the impacts of federal actions on wetlands and their related beneficial effects, such as ground water recharge. In carrying out any activities affecting wetlands, Federal agencies must consider such factors as: public health, safety, and welfare including such things as water supply and quality, recharge and discharge areas for ground water, pollution, etc. Other environmental concerns and uses of wetlands in the public interest must also be concerned.

16. EXECUTIVE ORDER 12088 - FEDERAL COMPLIANCE WITH POLLUTION CONTROL STANDARDS, OCTOBER 1, 1978

This Order directs the Executive agencies to take all necessary actions for the prevention, control, and abatement of environmental pollution as regards activities and facilities under the control of those agencies. The Order further directs those agencies to comply with both the procedural and substantive requirements of applicable pollution control standards, including RCRA, CERCLA, CWA, SDWA and State and local laws and rules to the to the same extent as any other person is required to do so. Thus, the order waives Sovereign Immunity for all environmental laws addressing pollution control even though sovereign immunity is not specifically waived by law (Legal Aid Society of Alameda county vs Brennan 608 F.2d 1319, 1329-31C 9th Cir. 1979 and Sierra Club V Peterson, 705 F.2d 1475 (1983)).

Compliance with the Order will therefore require BLM to comply with both State and local ground water requirements and with the requirements of pertinent Federal laws and regulations as they concern ground water which could be affected by BLM activities.

17. EXECUTIVE ORDER 12316 - RESPONSES TO ENVIRONMENTAL DAMAGE

This Executive Order (EO), which revokes EO 12286, addresses the National Contingency Plan (NCP) and superfund under CERCLA. The E.O responds to the mandate of CERCLA and modified the NCP established by the Clean Water Act to conform with the NCP requirements set forth CERCLA.

A national response team composed of representatives from 12 specified agencies including Interior, Defense, State, Justice, and EPA. Other agencies may be added as appropriate. Specific areas responsibility are assigned to the various agencies participating on the National Response Team (NRT). The agencies with membership on the NRT are obligated to provide critical resource assessment to the NRT if requested.

This EO also addressed Natural Resources and the assessment of damage to them. Four agencies are designated primary Federal Trustees of natural resources.

(1) Department of Defense
(2) Department of the Interior
(3) Department of Agriculture
(4) Department of Commerce.

Interior is given overall responsibility for Natural Resources under Federal jurisdiction. This responsibility includes the development of regulations for conducting Natural Resource Damage Assessments; including the assessment of damage to ground water.

A hazardous Substance Response Trust Fund is also set up in this EO. This fund, also known as the "Superfund," is for hazardous waste corrective actions provided for by the Act. A task force comprised of the representative agencies oversees the budget requirements of the fund and task force members may be responsible for a certain portion of the fund. A major use of the fund, historically, has been ground water protection.

18. EXECUTIVE ORDER 12372 - INTERGOVERNMENTAL REVIEW OF FEDERAL PROGRAMS

This Executive Order replaces OMB circular A-95 and the memorandum of November 8, 1968 (33 Fed. Reg. 16487, November 13, 1968). However, all rules and regulations issued under the previous two documents remain in effect until revised.

The Executive Order empasizes the reliance on State and local processes for the review and coordination by State and local governments of Federal financial assistance and direct development. It requires Federal agencies to provide opportunities for consulation by elected officials of State and local governments which would be directly affected by Federal action. To the extent permitted by law, the Federal agencies shall utilize the State process for determining official view, communicate with elected official early in the planning process, make efforts to accommodate State and local concerns and exploit decisions in a timely manner, seek coordination of views between States regarding interstate impacts, etc. The State process is also allowed to exclude certain Federal programs from review at the discussion of the responsible State and local official.

OMB is authorized to develop appropriate regulations and agencies are expected to develop rules and regulations addressing this issue.

III. RECONNAISSANCE LEVEL: METHODOLOGY

A. Data Collection

The first step in a Reconnaissance Investigation is to obtain all available published geologic information from the USGS, other Federal agencies, and state geologic agencies involved with ground water studies. Many of the USGS publications will provide valuable hydrogeologic, quantitative, and qualitative information. However, the hydrologic atlases, geologic maps, geologic quadrangle maps, and water supply papers will be especially helpful in providing interpretations of such data.

Many state Geological Surveys or state Water Resources Agencies have cooperative agreements with the USGS and other agencies to carry out field investigations. These offices, as well as the USGS District offices, may be good sources of detailed information for their jurisdiction.

General literature searches can exploit computer information storage and retrieval systems. Requests should be made to the library staff giving key words relating to the ground water system and location of the study area. The library staff can then provide a comprehensive print out of available literature which serves as a foundation for more indepth surveys.

Information pertaining to specific well locations, construction details, and logs may be obtained from the State Engineer, USGS, and other agencies. In addition, in-house information such as project files, well site reports, and the Central File (Code 7200 series) may be reviewed. Requests may be made to the USGS or the Ground Water Coordinator at DSC for individual well data from the Ground Water Site Inventory (GWSI) file of WATSTORE.

Additional water quality data may be obtained by searching EPA's STORET System in a latitude-longitude bounded polygon.

The above sources have been recommended for the purpose of initiating the Reconnaissance Investigation <u>because they are easily obtainable, published materials</u>. Consult the appendices for additional sources of hydrogeologic, qualitative, and quantitative water resources information.

B. Base Map Compilation

1. Indicate surficial geology and outcrops of subsurface units that serve as aquifers.

2. Indicate springs and their discharge.

3. Plot representative well locations.
Present associated well data in tabular form:

   a. Depth of well ("as built" and present)
   b. Depth of water (Note seasonal and historical changes.)
   c. Well yield (date of measurement)
   d. Name of producing formation and the interval screened or perforated (in feet below the surface) if available.
   e. Water use
   f. Date and time of measurement
   g. Elevation of ground surface at well
   h. Time since most recent pumping
   i. Casing dimensions
   j. Screen material and size
   k. Method used to seal annulus of well
   l. Date drilled

4. Delineate areas of recharge and discharge. Indicate general flow directions if water level contour maps are available.

C. Hydrogeologic Characterization

1. Identify geologic units and lithology.

2. Describe the aquifer thickness, saturated thickness, and areal extent.

3. Indicate the porosity and permeability for each unit.

4. Discuss confined and unconfined aquifers.

   a. Confined

      (1) Describe the depth to water to characterize aquifer conditions. Note the producing formation. Indicate the internal screened or penetrated (consult well records, drillers' logs) because evaluating confined aquifers on the basis of water levels alone can be misleading. This information may be hard to come by and must be tempered by knowledge of the local geology.

      (2) Determine if wells drilled in the aquifer would be artesian and flowing or artesian but not flowing. Both situations can occur in the same aquifer depending on the position at the land surface with respect to the potentiometric surface (Figure 1).

      (3) Indicate transmissivity and storativity in order to assess ground water development potential of the area, or the effects of heavy hydrologic stresses (as in mining). Remember fluctuations in these parameters represent changes in hydraulic head. If the water level data for a confined aquifer is from wells, be sure that the well is a true piezometer, only open to the aquifer at the intake. Determine these factors from the existing literature.

b. Unconfined

(1) Describe the relationship of the water table level to the land surface.

(2) Indicate the transmissivity of the aquifer. Although this parameter is not as well defined as in a confined aquifer, it still may be useful.

(3) Indicate the specific yield of the aquifer. This storage term is the same as storativity for confined aquifers although specific yield values are much higher. This means that compared to confined aquifers, the same yield can be realized with smaller head changes over less extensive areas. Walton (1970) presents techniques for defining hydrogeologic characteristics.

5. Discuss the relationships of structure and stratigraphy to ground water movement and storage.

6. If specific numerical information is not available, qualitatively describe the aquifer system. For example, aquifers in the Wasatch Formation near a coal project could be described as follows:

> "These units are quite variable, and can be good to very poor aquifers. There are many paleochannels where relatively permeable sandstones transmit enough water for successful water wells. Elsewhere, numerous clay layers can effectively perch water. These layers make it very difficult to describe regional aquifer characteristics. The thickness of the Wasatch Formation ranges from near zero in the coal outcrop regions to approximately 300 feet at the western edge of the study area.
>
> Numerous small stock wells have openings in these strata, and most water level maps of the area reflect the effects of gradients established by local drainages. In addition to rainfall infiltration, the units may be recharged by water in alluvial channels in the western part of the study area, and by water transmitted through clinker-overburden contacts. Most wells in the Wasatch are low yield stock wells, but wells which penetrate sandstone strata might produce up to 100 gpm. The percentage of the total discharge attributable to extraction from wells is not known, although it might be significant." (Everett, 1979, p. 112)

A summary of the various sources of geologic and hydrologic information applicable to the purpose of our assessments is presented in Tables 1 and 2.

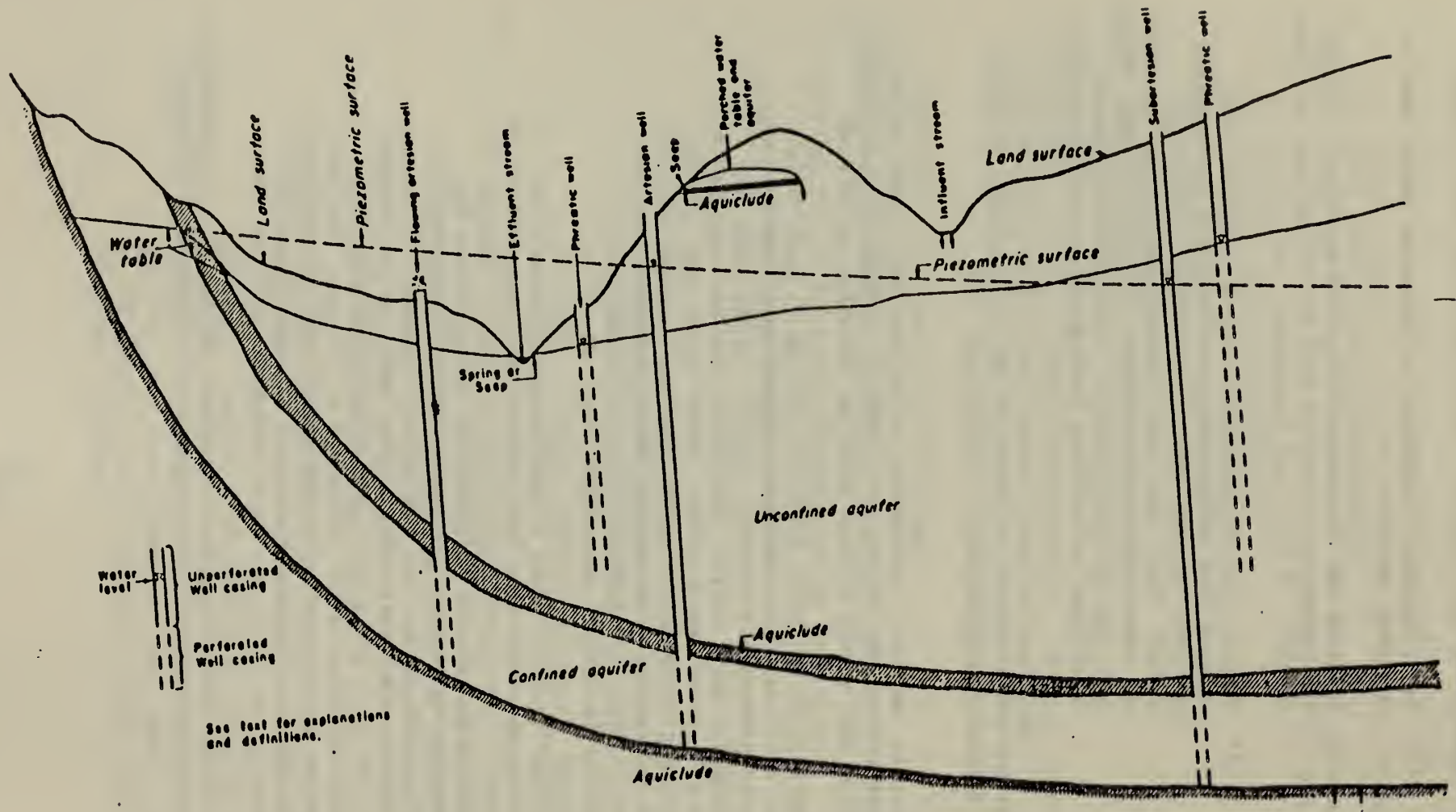


Figure 1 Ground-water Relationships

Table 1

TYPES AND SOURCES OF GEOLOGIC INFORMATION

Topic	Definition and Sources
Stratigraphy	Stratigraphic data are formational designations, age, thickness, areal extent, composition, sequence, and correlations. Aquifers and confining formations are identified so that units likely to transport pollutants can be delineated. Lateral changes in formations (facies change) are noted if present. Information can be obtained from the USGS library and from major state university libraries, in addition to sources mentioned previously. Contact the DSC librarian for interlibrary loans from the USGS or other libraries.
Structural Features	Structural features include folds, faults, joints/fractures, and interconnected voids (i.e., caves and lava tubes). Deformed, inclined, or broken rock formations can control topography, surface drainage, and ground water recharge and flow. Joints and fractures are commonly major avenues of water transport and usually occur in parallel sets. Solution features such as enlarged joints, sinkholes, and caves are common in limestone rocks and promote rapid ground water movement. Pertinent data on structural features would include type, compass orientation, dip direction and angle, and stratigraphy. Information can be obtained from the sources listed for "Stratigraphy".
Mineral Resources	Mineral resources refer to commercial deposits of minerals, quarry rock, sand/gravel, oil and gas. Such deposits near the study area are identified and located. These may represent pollutant sources to be considered when planning a sampling survey. Mines and quarries can often be used for direct examination of otherwise unexposed subsurface materials. USGS topographic maps show most mines/quarries and oil fields. Aerial photographs and ground level pictures from USGS studies can be helpful in identifying and locating these features. County soil surveys published by the U.S. Department of Agriculture are useful because they are printed as overlays on aerial photographs. They are available through state conservation offices. Other published and unpublished literature is available from sources listed for "Stratigraphy".
Seismic Activity	In active seismic zones, disposal site covers and liners may prematurely fail due to earth movement along faults. For this reason, fault locations and the seismic history of the study area are determined. A telephone call to the state geological survey is recommended as the first step when seeking this type of information (Appendix A, Part 6).

Topic	Definition and Sources
Formation Origins	Information about the origin of a deposit or formation (i.e., volcanic, metamorphic, stream-laid, etc.) gives clues to the hydrogeologist about structure, grain-size distribution (laterally and vertically), weathering, and permeabilities. Information can be obtained from sources listed for "Stratigraphy".
Weathering Profile	Bedrock and unconsolidated deposits, such as glacial till and windblown loess, develop characteristic weathering profiles. Zones in those profiles may be more permeable than others. The zones should be identified and characterized by composition and thickness. Weathering profiles for shallow depths (less than 10 ft) are usually presented in county soil survey maps and are discussed under "Mineral Resources".
Grain-size Distributions	Grain-size analysis, conducted on samples from unconsolidated formations, yields the proportion of material for a specified size range. Range distributions can be used to estimate permeabilities, design monitoring wells and enable the hydrologist to better interpret stratigraphy. Such analyses are most often performed during pre-construction engineering/soils studies for a site and may be obtained from local consulting firms in addition to other sources mentioned previously.

Table 2

TYPES AND SOURCES OF HYDROLOGIC INFORMATION

Topic	Definition and Sources
Surface Drainage	Surface drainage information includes tributary relationships, stream widths, depths, channel elevations, and flow data. The nearest permanent gaging station and period of record are also determined. A USGS 71/2 minute topographic map will show some of the necessary information. Gaging stations and flow data can be identified and obtained through USGS data bases (Appendix) and from the EPA NEIC Technical Information staff.
Ground and Surface Water Relationships	Streams near HWSs can either receive ground water inflow or lose water by channel exfiltration. Hydrologic literature is reviewed to determine if local streams are "gaining" or "losing". Losing streams are common in areas of limestone bedrock and those with arid climates and coarse-grained channel substrates. Potential ground water recharge areas are also identified. Flat areas or depressions noted on the topographic are suspect, while steep slopes normally promote runoff. Stereo-pair aerial photographs can be useful in these determinations (Appendix I, Part 3). Irrigated fields detected in aerial photographs suggest recharge areas; swampy, wet areas suggest areas of ground water discharge.
Underlying Aquifers	Information is collected to delineate aquifer type (unconfined, confined, or perched), composition, boundaries, hydraulic properties (permeability, porosity, transmissivity, etc.), and interconnection with other aquifers (direction of leakage). These data are generally available through geological survey publications.
Depth to Ground water	As used here, depth to ground water refers to the vertical distance from the ground surface to the standing water level in a well. In a confined aquifer, the depth to water represents a point on a "piezometric" surface. The depths will limit the types of equipment that can be used for purging and sampling. Probable ground water flow directions (both horizontal and vertical) are determined by comparing depths to water adjusted for estimated ground surface elevation. Data may be obtained from USGS and other data bases through the EPA NEIC Technical Information staff and various records listed in Appendix.

Table 2 (continued)

Topic	Definition and Sources
Water/Waste Contact	Possible ways that water could contact wastes are researched to understand how pollutants are carried into the environment and for later consideration in designing remedial measures. Possibilities include: 1. Precipitation falling directly on wastes 2. Precipitation infiltrating through cover materials 3. Floodwater (determine flood frequencies and elevations, compare to waste elevation) 4. Ground water (compare elevations of wastes and ground water) Pertinent information may be obtained from various records listed in Appendix A, Part 1 and from data bases accessed by the NEIC Technical Information staff.
Water Quality	The quality of ground and surface water in an area will define, to a large extent, potential uses. Leachate from an HWS can degrade water quality to the extent that practical uses is limited or terminated. Knowledge of natural or background water quality and water uses are required to assess leachate imports. The quality of surface waters is usually available from EPA, USGS, and state records (Appendix A, Part 1).

D. QUALITATIVE CHARACTERIZATION

1. Give a characteristic description of the water quality for a given aquifer in a given location. For example, several constituents may have a range of values and these should be rated.

2. Identify contaminants exceeding EPA's maximum contaminant levels (MCL's) or in marginal categories. The Environmental Protection Agency (EPA) has published the National Interim Drinking Water Standards (Fed. Register, Vol. 40, No. 248, Dec. 24, 1975). These regulations establish the maximum contaminant levels (MCL's) for numerous constituents (inorganic as well as organic) and some bacteriological standards. (BLM Manual 7240 addresses water quality related to Bureau programs.)

   The MCL's are divided into primary standards which are maximum permissible standards, and secondary standards, which are advisable maximum levels of contaminants.

   The primary (mandatory) standards are:

Arsenic	.05 mg/l
Barium	1.0 mg/l
Cadmium	.010 mg/l
Chromium	.05 mg/l
Lead	.05 mg/l
Mercury	.002 mg/l
Nitrate (as Nitrogen)	10.00 mg/l
Selenium	.01 mg/l
Silver	.05 mg/l

   The secondary (advisable) standards are:

Chloride	250 mg/l
Color	15 Color Units
Copper	1 mg/l
Corrosivity	Non-corrosive
Foaming Agents	0.5 mg/l
Hydrogen Sulfide	0.05 mg/l
Odor	3 Threshold Odor Number
pH	6.5-8.5
Sulfate	250 mg/l
TDS	500 mg/l
Zinc	5 mg/l

3. Identify concentrations of major ions. Such concentrations are often expressed in collins, stiff, Trilinear diagrams and pie charts. Should needed data be available in these forms, consult Appendix J for methods of interpretting them. The major diagnostic factors for detecting movement of pollutants are:

   *Major ions--calcium, magnesium, sodium, potassium, chloride, fluoride, silica, sulfate, nitrite and nitrate, iron, boron, and alkalinity, (as $CaCO_3$).

*Physical parameters--Solids, residue on evaporation at 180 C, specific conductance, pH (field and laboratory), and temperature, degrees C.

Consult Table 3 for Constituents in Industrail and Municipal Wastewater having significant potential for ground water contamination

Table 3

CONSTITUENTS IN INDUSTRIAL AND MUNICIPAL WASTEWATER HAVING SIGNIFICANT POTENTIAL FOR GROUND WATER CONTAMINATION

MINING (SIC 10, 11, and 12)

Metal and Coal Mining Industry (SIC 10, 11, and 12)

pH	Zinc	Magnesium
Sulfate	Tin	Silver
Nitrate	Vanadium	Manganese
Chloride	Radium	Calcium
Total Dissolved Solids	Phenol	Potassium
Phosphate	Selenium	Sodium
Copper	Iron	Aluminum
Nickel	Chromium	Gold
Lead	Cadmium	Fluoride
	Uranium	Cyanide

PAPER AND ALLIED PRODUCTS (SIC 26)

Pulp and Paper Industry (SIC 261 and 262)

COD/800	Phenols	Nitrogen
TOC	Sulfite	Phosphorus
pH	Color	Total Diss.
Heavy metals	Biocides	Solids

CHEMICALS AND ALLIED PRODUCTS (SIC 28)

Organic Chemicals Industry (SIC 286)

COD/BOD	Alkalinity	Phenols
pH	TOC	Cyanide
Total Dissolved Solids	Total phosphorus	Total nitrogen
Heavy metals		

Inorganic Chemicals, Alkalies, and Chlorine Industry (SIC 281)

Acidity/alkalinity	Chlorinated benzenoids and polynuclear aromatics	Chromium
Total dissolved solids		Lead
Chloride	Phenols	Titanium
Sulfate	Fluoride	Iron
COD/BOD	Total phosphorus	Aluminum
TOC	Cyanide	Boron
Mercury	Arsenic	

CHEMICALS AND ALLIED PRODUCTS

Plastic Materials and Synthetics Industry (SIC 282)

COD/BOD
pH
Phenols
Total dissolved solids
Sulfate
Phosphorus
Nitrate
Organic nitrogen
Chlorinated benzenoids and polynuclear aromatics
Ammonia
Cyanide
Zinc
Mercaptans

Nitrogen Fertilizer Industry (SIC 2873)

Ammonia
Chloride
Chromium
Total dissolved solids
Nitrate
Sulfate
Organic nitrogen compounds
Zinc
Calcium
Sodium
COD
Iron, total
pH
Phosphate

Phosphate Fertilizer Industry (SIC 2874)

Calcium
Dissolved solids
Fluoride
pH
Phosphorus
Acidity
Aluminum
Arsenic
Iron
Cadmium
Mercury
Nitrogen
Sulfate
Uranium
Vanadium
Radium

PETROLEUM AND COAL PRODUCTS (SIC 29)

Petroleum Refining Industry (SIC 291)

Ammonia
Chromium
COD/BOD
pH
Phenols
Sulfide
Total dissolved solids
Chloride
Color
Copper
Cyanide
Iron
Lead
Mercaptans
Nitrogen
Odor
Total phosphorus
Sulfate
TOC
Turbidity
Zinc

PRIMARY METALS (SIC 33)

Steel Industry (SIC 331

pH
Chloride
Sulfate
Ammonia
Cyanide
Phenols
Iron
Nickel
Tin
Chromium
Zinc

ELECTRIC, GAS, AND SANITARY SERVICES (SIC 49

Power Generation Industry (SIC 491

COD/BOD	Copper	Phosphorus
Polychlorinated biphenyls	Zinc	Organic biocides
Total dissolved solids	Chromium	Sulfur dioxide
Oil and grease	Other corrosion inhibitors	Heat

Municipal Sewage Treatment (SIC 495)

pH	Nitrate	Sulfate
COD/BOD	Ammonia	Copper
Alkalinity	Chloride	Tin
Detergents	Sodium	Zinc
Total dissolved solids	Potassium	Various Organics

E. INTERPRETATION

1. Assess Ground Water Development Potential

   Estimate well yields for undrilled or sparsely drilled areas.

   a. Interpretations of potential well yields based on lithology alone can be very misleading. Such estimates are usually at the following order of magnitude (Davis and DeWeist, 1966). They should be tempered with a knowledge of other limiting factors such as structure, stratigraphy, recharge, and depth to water. Reliance should be placed on already published interpretive analysis; however, if no information is available, inferences may be drawn from data from nearby areas with similar rock types and structural conditions. Make it clear in the report that the data is not site specific.

Metamorphic and plutonic rocks in various regions	10 to 25 gpm
Fine-grained sedimentary rocks	less than 5 gpm
Sandstones	5 to 200 gpm
Limestones sometimes yield more than 200 gpm, but more commonly yield	5 to 25 gpm
River deposits that originate from perennial streams	10 to 50 gpm

   Larger yields, 100 to 200 gpm, may come from alluvial aquifers where the permeable zone is at least 10 feet thick and the saturated zone is at least 40 feet thick. Yields of greater than 1000 gpm are not uncommon for alluvial wells where there is sufficient saturated thickness.

   Also determine the specific capacity of wells or the well yield per unit of drawdown as gal/min/ft of drawdown. This parameter is often more descriptive of the aquifer system than yields (see Fetter, 1980).

   b. Assess capability of the aquifer system to supply water for various uses.

2. Discuss land use based on water quality

   a. Identify potential problem areas on the base map. Indicate sources of contaminants and relate to recharge areas and general flow directions. For example, surface disposal of mining waste or oil field brine can affect ground water quality several miles away by infiltrating the saturated zone and entering the flow path. Flow directions of contaminants relative to known points of use are critical to pursuing or changing the investigation strategy.

   b. Determine the basis for particular water quality problems. For example, natural chemical interactions with rock units rather than man induced pollutants may be responsible for the water quality problem.

      Remember that Reconnaissance level interpretations of water quality problems are limited to previously developed graphs, charts, and diagrams and are not to be developed from raw data.

IV. INTENSIVE LEVEL: Methodology

A. Data Collection

If an Intensive Investigation of existing information is applicable to Bureau planning efforts, refer to the inventory requirements developed for the RMP process (Manual 1600). If the analysis is applicable to mining-related issues or hazardous waste disposal, consultation with the Ground Water Coordinator at the Denver Service Center and specialists in other agencies is recommended prior to conducting any detailed investigations.

The literature search for Level II uses the same sources as for Level I, but provides a more exhaustive research by including the following:

1. Identification of Data Gaps

   Review the references obtained in the Level I literature search and identify any data gaps or anomalies that may exist. This requires a clear understanding of the nature of the problem to be solved and serves as an impetus for continuing research to Level II.

2. Intensified Computer Search

   Review the bibliographies of the Level I sources to locate more specific information related to your problem. The librarians at DSC can retrieve such data for you.

3. Aerial Photograph Analysis

   Use of low altitude (1:24,000) air photos is recommended for observation of topography and drainage patterns which may provide clues as to the geologic structure governing ground water flow. See Appendix C for information on locating these sources.

4. Personal Contacts

   The State Engineer's office may be contacted for information on specific wells in the state. Level II calls for exhaustive searches to locate these kinds of data. The State Water Resources Agencies should also be able to provide information from localized studies which may be directed at similar problems occurring on BLM lands. Other agencies such as the Bureau of Reclamation, Water Conservation Districts, and State or County planning agencies may likewise provide useful information. (See Appendix I for list of agencies.)

   Local universities may reveal studies that prove useful to the inventory.

   USGS may furnish pertinent unpublished data.

   The hydrogeologist at the Denver Service may be contacted for specific technical assistance.

5. Field Verifications

a. Water Level Data

Some of the well data gathered during the literature search may be outdated, anomalous, or insufficient to meet the needs of the survey. Water level information, when related to the total depth of the well, is probably the most easily obtainable and useable field data to supplement existing data in a Level II Investigation. For techniques in measuring shallow wells use U.S. Bureau of Reclamation (1977) and Anderson (1964). Techniques for measuring greater wells (deeper than 1,000 ft) are described in Garber and Coopman (1968).

It is imperative to collect as much information as possible about wells identified during the site inspection as any of these may be potential monitoring wells. Drillers' logs and records of well construction should provide information about the screened interval as well as well construction information (i.e., types of perforations in the casing such as torch cut, slotted, wire wound screen, arched). This data can be used to generate maps of water level contour, water level decline, and direction of ground water flow.

b. Aquifer Pumping Tests

Quantitative aquifer characteristics should be determined to the maximum extent possible using existing aquifer test data. Because of the cost, difficulty, and amount of time involved, aquifer tests are seldom run in a Level II investigation. If no data are available for a specific area, an aquifer test may be run using existing wells, even if the locations are not ideal. If the test well is in the same geologic unit and no ground water barriers exist (faults, stratigraphic and lithologic changes), extrapolate the results to acquire data for the desired site. Recognize that such extrapolation is risky, requiring several assumptions concerning the hydrodynamics of the system.

Well yields can often be determined by talking to well owners, but because aquifer characteristics can change abruptly within a few hundred feet laterally, special considerations may merit a test of a single well to fill a data gap. Such a test may provide a good approximation of an aquifer's characteristics. The most useful information gained is the specific capacity of the well (yield divided by maximum drawdown). This can be used as an index of the well's capacity to produce; units are in gal/min/ft of drawdown.

Aquifer testing usually involves one or preferably more observation wells located some distance from the pumped well. Such testing provides useful information about the storage capacity and transmissivity of the aquifer, but is expensive to conduct, even in existing wells and observation holes.

c. Ground Water Quality Sampling

A comprehensive search of existing water quality data should suffice for Level II investigations, but in some cases there may be a critical need for a current water quality analysis. Before resorting to any ground water sampling, the following preliminary investigations should be completed:

1. Define hydrogeologic situation.
2. Define ground water usage.
3. Identify potential pollutants and their effects.
4. Assess existing ground water quality.
5. Evaluate infiltration potential or the potential movement of pollutants into the aquifer via other means.
6. Evaluate mobility and attenuation of pollutants.

To keep costs to a minimum, select wells for sampling which represent aquifers with insufficient data. Determine which water quality parameters are important to the study and sample in accordance with the techniques outlined in Chapter 2 of the Handbook on Recommended Methods for Water Data Acquisition (USGS, 1980b).

B. INTERPRETATION

The objectives of a Level II Interpretation are to develop a conceptual model of the ground water system (Figure 1). This involves evaluating its development potential and assessing the stresses (pumping) affecting the ground water system, and potential for contaminant transport.

Understanding ground water hydrology involves creating a three-dimensional image of the site. As hydrogeologic data are gathered, draw vertical cross-sectional diagrams for visualizing subsurface conditions and identifying data deficiencies. Delineate geologic formations, aquifers, structures, and water tables or confined aquifer pressure surfaces.

1. Develop a Conceptual Model of the Ground Water System

a. Consider the following as well as the hydrologic factors discussed in Level I.

Precipitation and Infiltration

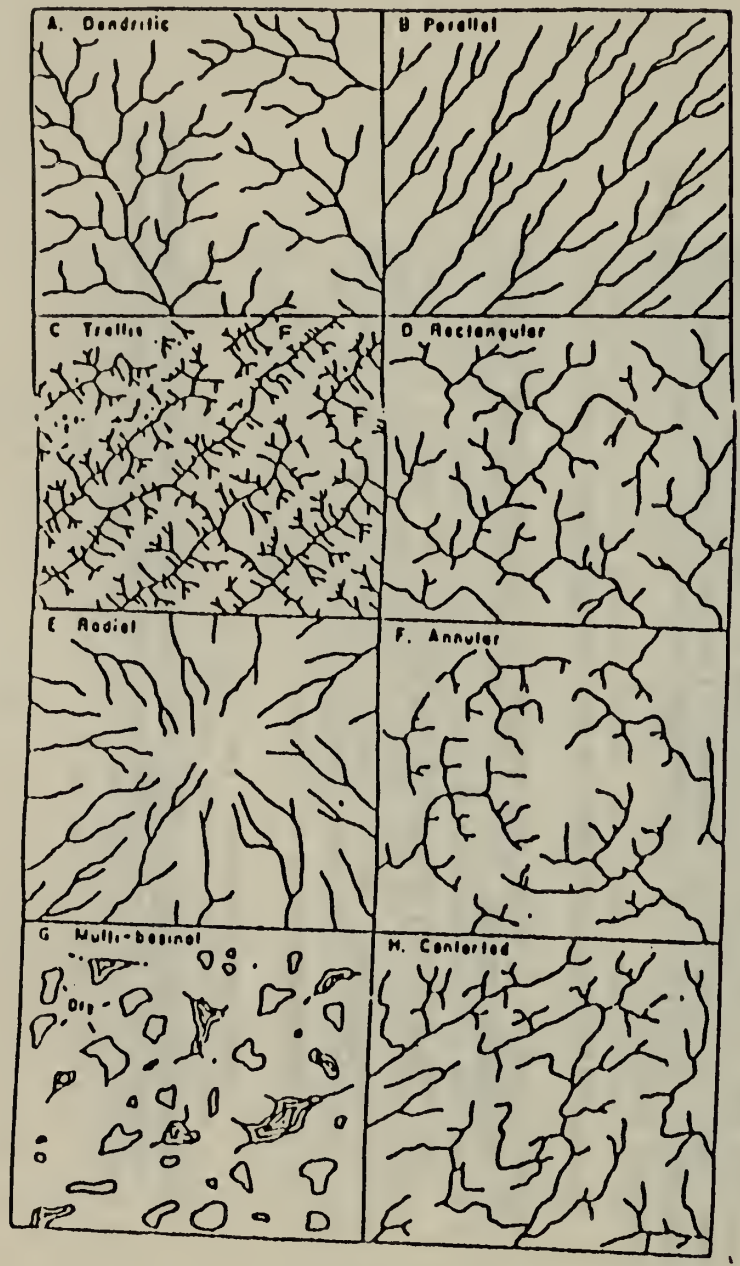
Vegetation

Topography

Drainage Patterns (see Fig. 2)

b. Plot all available water well information (see Level I parameters plus Level II collection) on a base map (may be Level I base map

Hydro Analysis Level II



A. Dendritic occurs on rocks of uniform resistance to erosion and on gentle regional slopes.

B. Parallel occurs on steep regional slopes.

C. Trellis occurs in areas of folded rocks with major divides formed along outcrops of resistant rocks and valleys on easily eroded rocks.

D. Rectangular occurs in areas where joints and faults intersect at right angle.

E. Radial occurs on flanks of domes and volcanoes where there is no effect of differing rock resistance.

F. Annular occurs on eroded structural domes and basins, where resistant outcrops form major divides and weak rocks form valleys (a concentric type of trellis pattern).

G. Multi-basinal occurs in areas where the original drainage pattern has been disrupted by glaciation, recent volcanism, limestone solution, or permafrost.

H. Contorted occurs in areas of complex geology where dikes veins, faults or metamorphic rocks control the pattern.
The fishhook patern of the main stream might also result from capture of a northeast flowing stream by the southward flowing main stream.

Fig. 2 - Basic Forms of Drainage Patterns and Associated Rock Types

if space permits). This may include information from unpublished sources and extrapolations developed to fill data gaps. Much can be revealed about the ground water system if data are abundant and fully plotted.

In the narrative indicate the range in well depths and depth to water in each unit.

For confined aquifers, briefly discuss the producing zone (depth), the amount of head in the system, and the formation (name) where the water originates.

Delineate aquifer boundaries and geologic outcrops by using surficial geologic information to show unconfined or water table conditions and subsurface geology correlated to outcrops of bedrock. Where ground water is at or near the surface, indicate its significance. For example, an area perennially wet may indicate not discharge from an unconfined or confined system but merely a local perched water table.

Plot directions of ground water movement for the study area on the aquifer map if space permits. This will depend on the density of wells.

Presentations of data useful at this level are: (1) ground water contour maps, (2) water level change maps, (3) ground water inflow-outflow maps, (4) direction of flow maps, (5) isosaline maps in areas of aquifers containing saline water, (6) water quality maps, and (7) saturated thickness maps.

Techniques for developing a water level contour map are described in Heath and Trainer (1981). A good description of water level change maps is given in United Nations (1977, p.143). For isosaline maps, see Kelly (1974).

c. Consider the water quality data. The Intensive Level of Interpretation may require the actual plotting of raw water quality data into Trilinear, Stiff, or Piper diagrams to fill gaps or confirm anomalies. Interpreting water-quality data can involve considerable extrapolation or interpolation. Time variability in water composition is usually less important than areal variations.

Delineate areal variations in water quality, aquifer by aquifer, relating the chemical distribution to ground water flow patterns and rock composition. This relationship is examined in detail by Hem (1970). Evaluate native plants as an indicator of ground water quantity and quality. For a good discussion of phreatophytes relative to groundwater, see Robinson (1958).

Where data suffice, prepare maps indicating time related conditions (historical, current, or projected), or general quality assessments (electrical conductivity or total dissolved solids), or particular facets of quality (nitrate concentration, temperature).

Standard methods for analysis of most organic and inorganic components of ground water are well advanced, including determinations of common mineral constituents, dissolved gases, radionuclides, pesticides, and trace metals. Methods of interpretation and presentation of data are described in Hem (1970), Heath and Trainer (1981), and Davis and DeWeist (1966).

List and discuss the water quality data obtained from the literature, records, and field observations. Relate current withdrawals to uses and discuss measures required for maintenance of water quality.

2. Quantitatively evaluate data on those stresses affecting the ground water flow system. Examples include mine dewatering, withdrawal, or waste disposal injection.

The response of a ground water system depends on the aquifer parameters (transmissivity and storage coefficient), the boundary conditions, and the positioning of the development within the system. In dealing with problems related to use of ground water resources, the hydrogeologist must relate draft to water level change with respect to time and space. In ground water systems the decline of water levels in a basin because of withdrawal will occur over a period of years, decades, or even centuries. Some water must be taken from storage in the system to create gradients toward a well. There are two implications to be gathered from these facts: (1) some water must always be mined (pumped) to create a development, and (2) the response times in a ground water system differ markedly from those in surface water systems (Nat. Acad. Sci., 1982, p. 52). The incompleteness of basic data does not dictate that quantitative evaluations of cause-and-effect relations cannot be made. Approximate solutions, based on existing data and properly qualified, can be of great importance. For example, the use of simple analytical models using estimated values for transmissivity or other aquifer properties can be used to predict drawdowns, yields, etc. (See list of analytical models available in Appendix K.) Microcomputers and handheld calculators can save substantial time and reduce costs of these analyses. These analytical techniques have been written for the HP-85 microcomputer and are available from the hydrogeologist at the Denver Service Center who can assist in running these models for a particular application.

3. Analyze the potential development capability of the ground water resource.

Utilize transmissivity data and analyze water level changes over time (where available). Pay attention to the time span in which water level fluctuations occur. Recurrent fluctuations of several feet over a short period would be significant and be cause for further investigation. In most ground water systems, replenishment and discharge of the aquifer is nonuniform in time and space; the hydrogeology is irregular and pumping stresses are rarely uniformly distributed. Solving ground water problems usually depends on both scientific principles and/or professional judgment.

Development of a ground water reservoir by pumping wells, or any other land-use activity that affects the reservoir, disturbs the natural inflow-outflow balance, or equilibrium. Major withdrawals commonly affect large areas of a ground water reservoir; water levels drop to supply the localities of pumping. Continued pumping may reduce or stop natural discharge from the reservoir, and further, may reverse gradients and induce flow from streams or other surface water bodies which normally were avenues of discharge.

Concepts have been advanced to cope with the myriad options in developing ground water reservoirs. The most common are sustained yield, safe yield, and optimum yield.

Sustained yield commonly refers to the quantity of water that can be withdrawn from a ground water reservoir year after year without progressive depletion of water in storage. Withdrawal rates are maintained at less than or equal to the sum of changes in recharge and discharge. Its usage generally applies only to the availability of water at the maximum possible perennial rate, and not to water-quality, environmental, and other land and water-resources concerns.

The term safe yield is used similarly, and often synonymously, in reference to the magnitude of yield that can be maintained over a long period of time. However, safe yield may encompass safety or the long-term quality of the water as well as the yield, or the quality of streams in hydraulic connection with the ground water reservoir, and still other hydrologic effects considered to be detrimental. Use of the term, therefore, requires establishment of allowable hydrologic impacts of the withdrawals.

Optimum yield is a broader term referring to the "most favorable" withdrawal plan, taking into account no only hydrologic considerations but also the myriad social, economic, and legal factors in water management (Water Resources Council, 1980). Owing to the obvious wide range of applications, the words "optimum" and "most favorable" must be defined by the planner in terms of planning and management.

In the planning of withdrawals, optimum yield choices may range from short-life, intensive extraction and perhaps conscious depletion of the reservoir, through longer-term sustained yield that extends the supply indefinitely but permits lesser rates of withdrawal, to the conservative extreme of maintaining the reservoir underdeveloped and secure for future needs. The planner must select the approach most favorable to established management goals. The hydrologist can assist but the decisions at this stage of planning are largely nonhydrologic.

The determination of optimum yield becomes infinitely more complex with escalating water-quality considerations, environmental and land management needs, water rights and other legal controls, and the social and political aspects of any major public matter. Indeed, optimal or most-favorable usage of ground water may only be determinable politically. (Water Resources Council, 1980).

APPENDICES

A. SUMMARY OF INFORMATION SOURCES

B. SOURCES LIST FOR GEOLOGIC AND HYDROLOGIC INFORMATION

C. SOURCES OF AERIAL PHOTOGRAPHS

D. STATE GEOLOGICAL SURVEYS

E. STATE AGENCY CONTACTS FOR GROUND WATER MANAGMENT AND PROTECTION

F. DATA BASES USEFUL IN HAZARDOUS WASTE INVESTIGATIONS AND MINERAL DEVELOPMENT REVIEWS

G. COMPUTER-BASED STATE AND SUB STATE DATA BASES

H. SOURCES OF INFORMATION ON EPA CERTIFIED LABS

I. LITERATURE SOURCES

J. INTERPRETTING WATER QUALITY DATA

K. MICROCOMPUTER GROUNDWATER MODELS

SUMMARY OF INFORMATION SOURCES

This appendix lists a variety of information sources and types potentially useful to hazardous waste site (HWS) and mineral related investigations. Several sources are keyed to other appendices where additional detail is presented. Evidentiary information should be corroborated by several sources, if possible.

	SOURCES	TYPES/COMMENTS
1.	EPA and State Environmental Office files for:	
	RCRA permits and applications	
	(Waste Generators and Transporters)	EPA Identification numbers
	Generator annual reports	
	TOSCA May require special clearance for reviewer	
	NPDES permits and applications	Liquid waste types
	Treatment processes	
	Production information	
	Uncontrolled waste disposal sites	
	Spills of oil and hazardous materials	
	Water supplies	Nearest water supply
	Enforcement actions	
	Surveillance reports	Problem history
	Previous findings	
2.	County or Regional Planning Agencies for Areawide Waste Treatment Mgmt. (CWA - Section 208 Agency)	Plans, concerns, and past problems
3.	Other County offices	
	Health Department	Problems, complaints, analytical results
	Planning and zoning	Land use restrictions
	Assessor	Plat maps and landowners
4.	City offices	
	Chamber of Commerce	Information and local industries including number of employees, principal products, and facility addresses

	SOURCES	TYPES/COMMENTS
	Clerk	
	Engineer	Foundation and inspection reports Survey benchmark locations
	Fire Department	History of fires and/or explosions at facility
	Law Enforcement	Complaints and violations of local ordinances
	Water and Sewer	Location of buried mains and lines
5.	Company files and records	Confidential records require special handling and storage
6.	Contractors Building	Local soils, geology, and shallow water levels
	Soil exploration and foundation Water well drillers	Local soils, geology, hydrogeology, water levels, regulations, and equipment availability
7.	Utility Companies Gas Electric Water Petroleum or Natural Gas Pipelines	Location of buried lines
8.	U.S. Geological Survey (See Appendix B, D)	Technical geologic and hydrologic reports, maps, aerial photographs, and water monitoring data
9.	Remote Sensing Imagery (see Appendix C)	Drainage patterns, land use, vegetation stress, historical land development, and geologic structure
10.	Computer Data Bases (see Appendix G)	Wide variety of reference data and bibliographies
11.	U.S. Department of Agriculture	Soil maps, types, physical characteristics, depths association, and uses

	SOURCES	TYPES/COMMENTS
12.	State Geological Surveys (see Appendix D)	Technical geologic and hydrologic reports, State geologic maps, and monitoring data
13.	U.S. Department of Labor Occupational Safety and Health Administration (OSHA)	Hazards Protective equipment needs
14.	National Oceanic and Atmospheric Administration (NOAA)	Climatic data

SOURCE LIST FOR INFORMATION NEEDED IN GROUND WATER INVESTIGATIONS

I. INTRODUCTION

Appendix B has been developed as an aid in locating and assembling currently existing basic ground water data and information contained in various agency data systems, files, reports, and other published and unpublished documents. The purpose of this appendix is to assist those less familiar with this specialty field in developing a basic data base and to provide a convenient data-source checklist for those more conversant with the field. All questions related to the acquisition availability or value of individual data items or related to the adequacy of a field office data base may be directed to the BLM staff hydrogeologist, Division of Resource Systems, at the Denver Service Center. The BLM hydrogeologist at the Denver Service Center should be contacted early in the data assemblance effort for assistance if needed.

II. MAPS

A. Geologic

1. USGS Geologic Quadrangle maps (GQ series)
2. USGS Geophysical maps (GP series)
3. USGS minerals investigations maps (MF and MR series)
4. USGS miscellaneous field studies and investigations maps (MF and I series)
5. USGS oil and gas investigations maps charts and maps (OC and OM series)
6. USGS coal investigation maps (C series)
7. USGS special geologic maps
8. USGS State geologic maps
9. USGS surface management and surface minerals maps (1:1,000,000 scale)
10. USGS separate map inserts from bulletins, professional papers, or water supply papers
11. USGS open file maps
12. State-published geological maps (generally 1:250,000 or 1:500,000 scale are available)
13. State geological survey office open-file geological maps

B. Ground Water

1. USGS hydrologic atlases (HA series)
2. USGS open-file ground water maps
3. State-published maps of aquifers
4. State-open-file ground water occurrence and quality maps
5. State ground water use maps
6. USGS water resource investigations (WRI series)

III. BOOKS, REPORTS, AND OTHER PERIODICALS

A. Ground Water and Geology Combined

1. USGS Bulletins and Circulars
2. Pertinent environmental impact statements
3. USGS professional papers (Geology)
4. USGS open-file reports (geology and ground water)
5. GeologicalSociety of America Bulletin
6. State geological survey reports, bulletins, and circulars
7. State geological survey open-file reports
8. BLM internal reports (e.g., EMRIA reports)
9. USGS open-file geologic maps (these are usually preliminary editions)
10. Reports on mining districts available from USGS and some state agencies (contained in USGS bulletins and professional papers)
11. USGS water supply papers
12. USGS reports on water resources data by states (published annually)
13. National Handbook of Recommended Methods for Water Data Acquisition (USGS)
14. State reports on ground water and aquifers (Dept. of Environmental Quality, etc.)
15. BLM ground water investigations and well reports (e.g., well site investigations, EMRIA reports)
16. Coal hydrology reports
17. USGS Regional Aquifer-System Analysis (RASA) Program Reports
18. American Association of Petroleum Geol. Bulletins (information on structural geology)
19. Catalogue of information on water data (USGS)
20. List of water resources investigations, by states (USGS)
21. Published list of state water resources investigations
22. Printouts of NAWDEX data
23. List of US EPA-published water resource documents (published quarterly)

IV. ABSTRACTS, BIBLIOGRAPHIES (INCLUDES GEOLOGY, GROUND WATER AND ANY RELATED SUBJECTS AND INDEXES

A. USGS Sources

1. "Publications of the Geological Survey, 1879-1961." (USGS)
2. "Publications of the Geological Survey" (USGS)
3. "Publications of the Geological Survey" (yearly USGS)
4. "New Publications of the Geological Survey" (monthly by USGS)
5. USGS list of geologic and water supply reports and maps by States
6. Geologic maps indexes by States (USGS)
7. Index to topographic maps in the United States by State (USGS)
8. Index to topographic maps on the United States, 1:250,000 and 1:1,000,000 scales (USGS)

9. Index to advance material available from current topographic mapping in progress by States (USGS)
10. Index to advance material available from the orthophoto mapping program by States (USGS)
11. Index to Landsat coverage (USGS)
12. Index to serial photography by States (USGS)
13. Catalog of information or water data (USGS)

B. State and Other Sources

1. "Bibliography of North American Geology"
2. State Index of geologic maps
3. State Index of geologic reports
4. GEO REF of American Geological Institute

V. TABULAR OR MACHINE READABLE DATA

A. Water Quantity Subcategory

1. USGS WATSTOR printouts
2. State Engineer water rights printouts (ground water)
3. State resource agency tabulations of available ground water quantity information
4. BLM records

B. Water Quality Subcategory

1. USGS WATSTORE printouts
2. USEPA STORET printouts
3. State Resources agency printouts

C. Water Use

1. USGS ground water use tabulations
2. State water engineer water use tabulations
3. Other State resource agency water use (ground water data base)

I. SOURCES OF AVAILABLE PHOTOGRAPHS

Information on and sources of aerial photographs and other imagery include:

1. U.S. Dept. of Agriculture
   Agricultural Research and Conservation Service
   Aerial Photography Field Office
   2222 West 2300 South
   P.O. Box 30010
   Salt Lake City, Utah 84125

   Most photos are at the following scales: (although other scales are available up to 1:80,000)
   1:15,840 or 1 inch = 1320 ft.
   1:20,000 or 1 inch = 1667 ft.
   1:40,000 or 1 inch = 3333 ft.

2. Rocky Mountain National Cartographic Information Center (NCIC)
   U.S. Geological Survey
   Building 25, Denver Federal Center, Room H-2206
   Denver, Colorado 80225
   (FTS) 234-2326

3. Environmental Photographic Interpretation Center (EPIC)
   P.O. Box 1587
   Vint Hill Farm Station
   Warrenton, Virginia 22186
   (FTS) 557-3110

4. Environmental Monitoring Systems Laboratory (EMSL)
   P.O. Box 15027
   Las Vegas, Nevada 89114
   (FTS) 595-2969

5. BLM photography includes low level aerial photography plus some high altitude photos from the EROS Data Center, Sioux Falls, SD. Information is available from:

   U.S. Dept. of Interior
   Bureau of Land Management
   Denver Service Center
   Denver Federal Center, Bldg. 50
   Lakewood, CO 80225

EMSL is capable of flying both simple and sophisticated remote sensing missions. Their equipment ranges from mapping quality black and white or color cameras to multispectral scanners with a variety of airborne sensor platforms. Generally, they can provide full remote sensing services to governmental organizations.

Appendix D,

STATE GEOLOGICAL SURVEYS

Arizona
Arizona Bureau of Geology and
Mineral Technology
845 N. Park Avenue
Tucson, AZ 85719
602-626-2733

California
California Division of Mines and Geology
Department of Conservation
1416 Ninth St.
Sacramento, CA 95814
916-445-1923

Colorado

Colorado Geological Survey
Department of Natural Resources
1313 Sherman Street, Room 715
Denver, CO 80203
303-866-2611

Idaho

Idaho Bureau of Mines and Geology
Moscow, ID 83843
208-885-6785

Montana

Montana Bureau of Mines and Geology
c/o Montana College of
Mineral Science and Technology
Butte, MT 59701
406-496-4166

Nevada

Nevada Bureau of Mines and Geology
University of Nevada
Reno, NV 89557
702-784-6691

New Mexico
New Mexico Bureau of Mines and
Campus Station
Socorro, NM 87801
505-835-5302

Oregon
Oregon Department of Geology
and Mineral Industries
1068 State Office Building
Portland, OR 97201
503-229-5580

Utah
Utah Geological and Mineral
Survey
Department of Natural Resources
606 Black Hawk Way
Salt Lake City, UT 84108
801-581-6831

Washington

Washington Division of Geology
and Earth Resources
Department of Natural Resources
Public Lands Bldg.
Olympia, WA 89504
206-459-6372

Wyoming

Geological Survey of Wyoming
Box 3008
University Station
Laramie, WY 82071
307-742-2054

STATE AGENCY CONTACTS FOR GROUND WATER MANAGEMENT AND PROTECTION

	Management	Protection
Arizona	Planning Division Arizona Dept. of Water Resources 222 North Central, Suite 850 Phoenix, AZ 85004	Bureau of Water Quality Control 1740 W. Adams Street Phoenix, AZ 85007
California	California Dept. of Water Resources P. O. Box 388 Sacramento, CA 95802 916-445-2182	Water Resources Control Board P. O. Box 100 Sacramento, CA 95801 916-322-8353
Colorado	Water Quality Control Division Colorado Department of Health 4210 E. 11th Avenue Denver, CO 80220 303-320-4163	Water Quality Control Division Colorado Department of Health 4210 E. 11th Avenue Denver, CO 80220 303-320-4163
Idaho	Idaho Dept. of Water Resources Statehouse Boise, ID 83720 208-334-4440	Water Quality Bureau Dept. of Health & Welfare Statehouse Boise, ID 83720 208-334-4255
Montana	Montana Dept. of Natural Resources 32 South Ewing Helena, MT 59620 409-449-3962	Montana Department of Health and Environmental Sciences Water Quality Bureau Capitol Station Helena, MT 59620 406-449-2406

	Management	Protection
Nevada	State Engineer Dept. of Conservation and Nat. Resources 201 So. Fall Street Carson City, NV 89710	Nevada Dept. of Natural Resources Div. of Environmental Protection Water Quality Section 201 Fall Street Carson City, NV 89710
New Mexico	State Engineer's Office Natural Resources Dept. Bataan Memorial Building Santa Fe, NM 87503	Water Pollution Control Bureau Ground Water Section P. O. Box 968 Santa Fe, MN 87503
Oregon	Oregon Dept. of Water Resources Ground Water Section 555 13th Street, N.E. Salem, OR 97310	Oregon Dept. of Environmental Quality Water Quality Division P. O. Box 1760 Portland, OR 97207
Utah	Utah Division of Water Rights Dept. of Natural Resources 1636 W. North Temple Salt Lake City, UT 84116 801-53f3-6071	Bureau of Water Pollution Div. of Environmental Health Utah Department of Health 150 W. North Temple, Room 426 Salt Lake City, UT 84110 801-533-6146
Washington	Water Quality Planning and Management Section Department of Ecology M/S PV-11 Olympia, WA 98504 206-459-6074	Water Quality Planning and Management Section Department of Ecology M/S PV-11 Olympia, WA 98504 206-459-6074
Wyoming	Wyoming State Engineer's Office Barrett Building Cheyenne, Wyoming 82002	Wyoming Dept. of Environ. Quality Solid/Hazardous Waste Management 401 West 19th St. Cheyenne, WY 82002 Wyoming Dept. of Environ. Quality Water Quality Divison 1111 E. Lincoln Way Cheyenne, WY 82002

SELECTED DATA BASES FOR HAZARDOUS WASTE SITE INVESTIGATIONS

Data Base Name	Subject Coverage	Coverage Dates	Update Frequency	Sponsoring Agency	Comments
AGRICOLA	Covers worldwide journal and monographic literature in agriculture and related fields, including general agriculture and rural sociology; animal science; forestry and plant-related areas; entomology; and agricultural engineering. Includes agriculture Canada.	1970-Pres.	Over 1 million citations, Monthly updates	U.S. National Agricultural Library	Citations only
APTIC	Covers most sources for citations concerning all aspects of air pollution, its effects, prevention and control.	1966-Oct. 1978	89,000 citations	Manpower and Technical Information Branch EPA.	Abstracts
ASI	American Statistics Index covers statistical publications containing the entire spectrum of social economic and demographic data collected and analyzed by all branches and agencies of the U.S. government.	1973-Pres. (some material from 1960's).	Over 55,000 citations, monthly updates.	Congressional Information Service, Inc.	Abstracts
BIOSIS PREVIEWS	Covers all aspects of the life sciences, drawing upon all original published literature for citations. Corresponds to Biological Abstracts/RRM.	1969-Pres.	2,265,000 records; Monthly updates.	Information Service	Bioscience only
CA CONDENSATES 70-71	Covers all aspects of the chemical literature both applied and theoretical. Corresponds to Chemical Abstracts.	1970-1971	585,000 records	Chemical Abstracts Service	Citations only
CA CONDENSATES/ CASIA	Gives general subject index headings and CAS registry numbers for documents covered by CA condensates.	1972-Pres.	Corresponds to CA Condensates after initial file load. Biweekly updates.	Chemical Abstracts Services	Description and identifiers only

SELECTED DATA BASES FOR HAZARDOUS WASTE SITE INVESTIGATIONS (Cont.)

Data Base Name	Subject Coverage	Coverage Dates	Update Frequency	Sponsoring Agency	Comments
CAB ABSTRACTS	Comprehensive file of agricultural information pertaining to all significant material and covering every aspect of crop and animal science.	1973-Pres.	Over 966,000 items. Monthly updates.	The Commonwealth Agricultural Bureau	Abstracts
CANCERLIT	(Formerly Cancerline). Contains information on various aspects of cancer taken from over 3,000 U.S. and foreign journals as well as selected monographs, papers, reports and dissertations.	1963-Pres.	Over 100,000 Abstracts of Articles; Updated monthly	National Cancer	Abstracts
CHEMDEX	Chemdex is based on the CA Registry Nomenclature File, which is a repository for names associated with substances that have been registered by Chemical Abstracts. In addition to CA's rigorous nomenclature data, this file contains registry numbers, molecular data, this file contains registry numbers, molecular formulas, synonyms and ring system information.	Contains all substances cited in the CA Abstracts volumes since 1972.	694,461 substances; quarterly updates	Chemical Abstracts Service of the American Chemical Society	
CHEMLINE	Chemline is an outline chemical dictionary file providing a mechanism for searching and retrieving chemical substance names. It contains 439,812 records for chemicals that are identified by chemical abstracts service registry numbers and are cited in either Toxline, Toxback, TDB, or RTECS.		Irregular updates	National Library of Medicine	
CHEMNAME	Contains CAS registry numbers, CA substance index names, molecular formulas, chemical name synonyms and periodic classification terms for chemical substances.	Corresponds to CASIA	737,000 substances; quarterly updates	Chemical Abstracts Service and Lockhead	Gives name and CAS re stry numbe only
CLAIM	U.S. chemical and chemically-related p s	1950-1970	265,000 citat	IFI/Plenum	Citations

SELECTED DATA BASES FOR HAZARDOUS WASTE SITE INVESTIGATIONS (Cont.)

Data Base Name	Subject Coverage	Coverage Dates	Update Frequency	Sponsoring Agency	Comments
COMPREHENSIVE DISSERTATION ABSTRACTS	Interdisciplinary listing of almost all doctoral dissertations accepted since 1861 by accredited degree granting institutions in the U.S. plus some non-U.S. universities.	1861-Pres.	Over 648,000 citation. monthly updates	Xerox University Microfilms	Citations only
CONFERENCE PAPERS INDEX	Covers approximately 1,000 scientific and technical meetings worldwide and the 100,000 papers presented.	1973-Pres.	715,000 records monthly updates	Data Courier	
EDB	The energy data base covers all information of interest to DOE in almost every area of research.	1974-Pres. (Contains material back to late 1800's	98,700 citations. 5,000 items semi-	DOE Technical Information Center monthly	Abstracts (after June 1, 19
EIS INDUSTRIAL	Information on 130,000 establishments operated by 67,000 firms with current annual sales of over $500,000 describing employment, sales, market share and production.	Current	140,000 records; replaced 3 times/year	Economic Information Systems	Citations only
EMI (EMIC)	Environmental mutagens - information concerning chemical mutagen research.	1976-Pres.		DOE-TIC	Abstracts
ENVIRONMENTAL PERIODICALS BIBLIOGRAPHY (EPB)	Covers the very board field of general human ecology, atmospheric studies, energy, land resources, water resources and nutrition and health from 300 periodicals.	1973-Pres.	Over 158,000 records. Bimonthly updates	Environmental Studies Institute	Citations
EXCERPTA MEDICA	Covers all fields of medicine plus extensive coverage of the drug and pharmaceutical literature and other areas such as environmental health and pollution control.	June 1974-Pres.	1,160,000 records, monthly updates	Excerpta Media	Abstracts

SELECTED DATA BASES FOR HAZARDOUS WASTE SITE INVESTIGATIONS (Cont.)

Data Base Name	Subject Coverage	Coverage Dates	Update Frequency	Sponsoring Agency	Comments
FEDERAL INDEX	Substantive comments from the Congressional Record, Federal Register, Presidential documents, and the Washington Post. Trends and developments in Washington are provided by citations to the Code of Federal Regulations, the US Code, public laws, congressional bills, and resolutions and reports. Coverage extends to proposed rules, regulations, bill introductions, speeches, hearings, roll calls, reports vetoes, court decisions, executive orders, contract awards, etc.	Oct. 1976-Pres.	130,000 citations, monthly updates	Predicasts	Citations only
FEDERAL REGISTER	Contents correspond to the Federal Register Abstracts	March 1977-Pres.	Weekly	Capital Services	Citations
GEOARCHIVE	Covers geoscience information. Mineral and petroleum production and resources and new names typify the data currently added to the fields of geophysics, geochemistry, geology, paleontology and mathematical geology.	1969-Pres.	290,000 citations; monthly updates	Geosystems of London	Abstracts
GEOREF	Covers geosciences literature from 3,000 journals, plus the geosciences conferences and major symposia and monographs in all areas of the geosciences.	1961-Pres.	360,000 items; 4,000 records/ month	American Geological Institute	
IPA	Information on all phases of development and use of	1970-Pres.	43,000 items 500-600 added monthly	American Society of Hospital Pharmacists	
MEDLINE	Bibliographic citations to worldwide	1976-Pres.	Over 815,000	National	stracts

SELECTED DATA BASES FOR HAZARDOUS WASTE SITE INVESTIGATIONS (Cont.)

Data Base Name	Subject Coverage	Coverage Dates	Update Frequency	Sponsoring Agency	Comments
MGA	Covers meteorological and geoastrophysical research published in both foreign and domestic literature. Based on Meteorological and Geoastrophysical Abstracts.	1970-Pres.	43,500 citations, irregular updates	American Meteorological Society	Abstracts
NAWDEX	National Water Data Exchange - Contains information concerning water data availability, source and some major data characteristics.	1700's-Pres	As necessary data from 61,500 sites stored.	U.S. Geological Survey	
NBI	National Biomonitoring Inventory - Information on on-going biomonitoring projects in the U.S.	Current	As necessary	DOE-TIC	Abstracts
NCC	National Climatic Center - Contains historical and current weather information and related data. The data is generated by: NOAA's Weather Service; the U.S. Navy and U.S. Air Force weather Service; the Federal aviation Administration; the U.S. Coast Guard; and cooperative observers.	1800's-Pres.	Continuous	National Oceanic and Atmospheric Admin.	
NRC	The National Referral Center file is non-bibliographic file containing description of organizations qualified and willing to answer questions on virtually any area of science and technology, including the social sciences.	Current		National Referral Center for Science & Technology	Citations only
NSA	Nuclear Science Abstracts - Subject scope includes all of nuclear science and technology.	1967-1976	554,597 records; closed	DOE-TIC	Abstracts
NSC	Covers all pertinent literature on nuclear safety information.	1963-Pres.	101,340 items; 1,000 citations per month	Nuclear Safety Information Center, Oak Ridge National	Abstracts

SELECTED DATA BASES FOR HAZARDOUS WASTE SITE INVESTIGATIONS (Cont.)

Data Base Name	Subject Coverage	Coverage Dates	Update Frequency	Sponsoring Agency	Comments
NSR	The Nuclear Structure Reference data base contains: 1. The entire contents of "Nuclear Structure References, 1969-1974," supplement to Vol. 16, Nuclear Data Sheets. 2. Complete contents of the 1975 "Recent References" issues of Nuclear Data Sheets; and 3. References to reports and informal communications (secondary sources) received by the nuclear data project during the years 1973-1975.	1974-Pres. 5,000 entries	30,236 items; 5,000 entries per year	Oak Ridge National Laboratory	Citations only
NTIS	Complete government reports announcement file. Contains abstracts of research reports from over 240 governments agencies including NASA, EPA, HEW, etc.	1964-Pres.	765,000 citations; biweekly updates	National Technical Information Service	Abstracts
OHM-TADS	Oil and Hazardous Materials-Technical Assistance Data System contains data on materials that have been designated oil or hazardous materials. The system is designed to provide technical support for dealing with potential or actual dangers resulting from the discharge of oil or hazardous substances.	Oct. 1978-Pres.		EPA-Oil & Special Materials Control Division	
PARCS	Pesticides Analysis Retrieval and Control Systems (PARCS) provides a centralized source of information on all pesticides registered by EPA.			EPA	
POLLUTION ABSTRACTS	Corresponds in coverage to the printed abstracts publication. Covers foreign and domestic reports, journals, contracts and patents, symposia, and government documents in the areas of pollutions control and	1970-Pres.	68,500 citations; bimonthly updates	Data Courier, Inc.	Citations only

SELECTED DATA BASES FOR HAZARDOUS WASTE SITE INVESTIGATIONS (Cont.)

Data Base Name	Subject Coverage	Coverage Dates	Update Frequency	Sponsoring Agency	Comments
RASS	Rock analysis Storage System - Contains information on samples submitted for analytical work. Information includes location, formation, sample name, age, descriptions, economic geology, data, and geochemical data.	1962-Pres. 1968-Pres. (2 files)	As necessary 135,000 records 292,000 records	U.S. Geological	
RING DOC	RINGDOC covers over 400 of the world's scientific journals to provide extensive coverage of the pharmaceutical literature. Access points to the citations include keywords and multipunch coded data (representing chemical fragments).	1964-Pres.	466,000 items 10,000 items/ month	Derwent Publications, Ltd.	Available to subscribers only
RTECS	Registry of Toxic Effects of Chemical Substances.	1978	40,967 records	NIOSH	
SAFETY	Safety provides international coverage of the literature in 6 major areas: general safety, industrial and occupational safety, transportation safety, aviation and aerospace safety, and medical safety.	June 1975-Pres.	Updated bi-monthly	Cambridge Scientific Abstracts, Riverdale, MD	Abstracts
SCISEARCH	Multidisciplinary index to the literature of science and technology. Based on Science Citation Index which indexes approximately 2,600 major scientific and technical journals.	1974-Pres.	2,970,000 citations; monthly updates	Institute for Scientific Information	Citations only
STORET	Storage and retrieval of water quality data - repository for water quality data that contains records of water quality parametric data by sampling site.	1976-Pres.	Bi-monthly	Paint Research	Abstract
TOXICOLOGY DATA BANK (TDB)	Contains facts and data from some 80 standard references textbooks, handbooks, monographs, and criteria documents, for approximately 2500 substances; 1100 of these have been completed; 1500 are in process. TDB contains approximate 60 different categories of data, such as chemical, physical, biological, pharmacological, toxicological, and environmental facts.	1978-Pres.	2500 Substances	National Library of Medicine	

SELECTED DATA BASES FOR HAZARDOUS WASTE SITE INVESTIGATIONS (Cont.)

Data Base Name	Subject Coverage	Coverage Dates	Update Frequency	Sponsoring Agency	Comments
TOXLINE	Contains data on toxicity and adverse effects of environmental pollutants and chemicals on the human food chain, laboratory animals, and biological systems; and analysis techniques in the following subfiles: CBAC - 1965-76 - Chemical abstracts, biochemistry sections. EMIC - 1971-74 - Environmental Mutagen Information Center. HAYES - 1970 - EPA Pesticide File. HEEP - 1971-76 - Health Effects of Environmental Pollutants IPA - 1970-76 - International Pharmaceutical Abstracts PESTAB - (Formally HAPAB) - 1966-76 - Pesticide Abstracts, EPA TERA - 1971-1974 - Teratology TMIC - 1971 - Toxic Materials Information Center TOXBIB - 1968-76 - Index Medicus Toxicity Subset	Varies with subject file	Varies with subject file. 479,926 records	National Library of Medicine	Citations; (Abstracts available)
WATSTORE	Water Data Storage and Retreival System - Contains data on the occurrence, quantity quality, distribution, and movement of surface and underground waters.	Historical-Pres.	As necessary Includes data on over 100,000 sites	U.S. Geological Survey	

SELECTED DATA BASES FOR JANUARY 1981 (Cont.)

Data Base Name	Subject Coverage	Coverage Dates	Update Frequency	Sponsoring Agency	Comments
WESTLAW	Contains Supreme Court full text and headnote summaries from 1932 - present; headnote summaries for all reported Federal court cases from 1960 - present; and all reported State Appellate Court cases from 1967 - present. Full test accessible for all Federal court cases from 1977 - present. The subfiles correspond to the units of the West Company National Reporter System.	1932-pres.	Number of items varies with subject files	West Publishing Company	
WRA	Corresponds to the semi-monthly abstracting journal, Selected Water Resources Abstracts. Covers the water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use or management of water. Input material for the abstracts comes from selected organizations with active water resources research programs which are supported as "Centers of Competence."	1969-Pres.	94,610 items 1,000 items/mon.	Water Resources Scientific Information Center	Abstracts

COMPUTER-BASED STATE AND SUB-STATE DATA BASES

STATE - DATA BASE NAME	AGENCY
Arizona	
Digital Topo Data base	Arizona State Land Department
California	
Land use	Department of Water Resources
Division of Land Resources Protection-Soils Program	Department of Conservation
Colorado	
Colorado Resource Information System	Department of Natural Resources
Idaho	
Land Information and Mapping System	Department of Lands
Idaho Water Rights	Department of Water Resources
Idaho Water Use Data System	Department of Water Resources
Montana	
Montana Water Quality Records System	Department of Health Water Quality Bureau
Stream Flows	Department of Natural Resources and Conservation
Nevada	
Ground Water	Department of Data Processing
Surface Water	Department of Data Processing
New Mexico	
New Mexico Natural Resources Information System	Natural Resources Department
Water Use Data	State Engineer Office

North Dakota	
Annual Use Reports on Water Permits	State Water Commission
Abandoned Mine Lands	Public Service Commission
Oregon	
Minerals Registry	State Land Division
Ground Water Sources and Aquifer Data observation well net	Water Resources Department
Water Quality (WATSTORE & STORET)	Water Resources Department
Streamflow Records	Water Resources Department
Water Rights	Water Resources Department
Utah	
UGMS CRIB File	Utah Geological and Mineral Survey
Washington	
Water Quality Classifications Monitoring Stations and Non-Changing Data	Department of Ecology
AIMS (Surface Mining Permits)	Department of Natural Resources
GRIDS - Gridded Resource Inventory Data System	Department of Natural Resources
Wyoming	
Wyoming Water Resource Data System	Wyoming Water Resources Center

REGIONAL QUALITY-ASSURANCE COORDINATORS

The following offices can provide you with the names and locations of state or EPA certified laboratories in your state. Ask the Quality Assurance Officer or the Environmental Sources Division Director.

Region 1 (Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island)

Quality Assurance Officer
Central Regional Laboratory
Environmental Services Division
U.S. Environmental Protection Agency
60 Westview Street
Lexington, Massachusetts 02173

Region 2 (New York, New Jersey)

Quality Assurance Officer
Environmental Services Division
U.S. Environmental Protection Agency
Edison, New Jersey 08837

Region 3 (Pennsylvania, Virginia, West Virginia)

Quality Assurance Officer
Water Quality Monitoring Branch
U.S. Environmental Protection Agency
Sixth and Walnut Streets, Curtis Building
Philadelphia, Pennsylvania 19106

Region 4 (Kentucky, North Carolina, Tennessee, Mississippi, Alabama, Georgia, South Carolina, Florida)

Quality Assurance Officer
Laboratory Services Branch
Environmental Services Division
U.S. Environmental Protection Agency
College Station Road
Athens, Georgia 30613

Region 5 (Wisconsin, Illinois, Indiana, Ohio, Michigan)

Quality Assurance Officer
Environmental Services Division
U.S. Environmental Protection Agency
536 South Clark Street
Chicago, Illinois 60605

Region 6 (New Mexico, Texas, Oklahoma, Arkansas, Louisiana)

Quality Assurance Officer
Environmental Services Division
U.S. Environmental Protection Agency
1201 Elm Street
First International Building
Dallas, Texas 75270

Region 7 (Nebraska, Iowa, Missouri, Kansas)

Quality Assurance Officer/Chief
Laboratory Branch
Environmental Services Division
U.S. Environmental Protection Agency
25 Funston Road
Kansas City, Kansas 66115

Region 8 (Montana, North Dakota, South Dakota, Wyoming, Colorado, Utah)

Quality Assurance Officer
Environmental Services Division
U.S. Environmental Protection Agency
Lincoln Tower Building, Suite 900
1860 Lincoln Street
Denver, Colorado 80295

Region 9 (California, Nevada, Arizona)

Quality Assurance Officer
Office of Quality Assurance and Monitoring Systems
U.S. Environmental Protection Agency
215 Fremont Street
San Francisco, California 94105

Region 10 (Washington, Oregon, Idaho)

Quality Assurance Officer
Environmental Services Division
U.S. Environmental Protection Agency
1200 Sixth Avenue, Mail Stop 345
Seattle, Washington 9810

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Appendix J.

a. Collins and Stiff Diagrams

The most widely used graphical procedure for displaying ion concentrations is the bar graph system developed by Collins (1923). In his method, each analysis is represented by a vertical bar graph whose total weight is proportional to the total concentration of anions or cations (Figure 3). The left half of the bar represents cations and the right half anions. Horizontal lines separate various ions. Usually six divisions are used, although more can be added. Hardness data may also be shown on this diagram (Figure 4).

Another widely used method is the Stiff diagram developed by H.A. Stiff in 1951. This method gives a distinctive pattern and is useful in depicting water composition differences or similarities. Four parallel horizontal axes extend from a vertical zero axis. Eight concentrations, expressed in milliequivalents per litre, are plotted on the axis, four cations to the left of zero, and four anions to the right of zero. The ions must always be plotted in the same sequence. Connecting the resulting points gives an irregular pattern (Figure 5). The width of the pattern indicates the total ionic content.

b. Mapping symbols

A vector system of map symbols was developed by Rezso Maucha of Hungary where the length of six vectors represents the concentrations of one or more ions in milliequivalents per liter. Though seldom used in the United States, this system is useful for plotting analytical values in a small space such as on a map (see Figure 6, Hem, 1970)

The map symbol system, developed by Colby, Hernbree, and Rainwater (1956), presents four components ($Ca^{+2} + Mg^{+2}$, CO_3, $Na^+ + K^+$, and $Cl + SO_4 + NO_3$) on rectangular coordinates. The kitelike figure resulting from connecting the four points makes a convenient symbol to use (Figure 7).

c. The Trilinear Diagram

Trilinear diagrams are also useful and have been developed by several authors. One of the earliest applications was in analyzing mine-water composition (Hem 1970, p. 264).

Piper (1944) developed a form of the trilinear diagram that effectively segregates analysis data for critical study with respect to sources of the dissolved constituents in ground waters, modifications in the character of a water as it passes through an area, and related geochemistry matters. For the Piper trilinear diagram, ground water is viewed as containing only three cations (Mg^{+2}, Na^+, and Ca^{+2}) and three anions (Cl, SO_4, and HCO_3). The triangular field at the lower left contains the

cations group percentage (Ca, Mg and Na), and the triangular field at the right contains the anion group percentage (HCO_3, SO_4, and Cl). Each point, one in each field, indicates the relative concentration of the three components. The central diamond-shaped field is used to show the general character of the water. Rays are projected upward from the triangle plots parallel to the triangle axes; the intersection of each pair of rays plots as a point on the diamond field. Ground water quality types can then be quickly discriminated by their position within the diamond-shaped field (Figures 8-10). Trilinear diagrams are especially useful in making interpretations regarding mixing of waters from different aquifers. They should not be used solely, but in support with other kinds of interpretations.

Trillinear diagrams are usually not statifactory for large areas. Ground water quality for large areas (and perhaps for several aquifers) can be illustrated by superimposing available Stiff diagrams on a map of suitable scale. At this level (reconnaissance) of analysis, this should be done only if Stiff diagrams are already drawn and can readily be transferred to a map. Small changes in quality can be detected easily because the diagram produces a readily recognized shape. Consistent positioning of the diagrams on the map in relation to the print source can minimize confusion.

d. Pie charts plotted on base maps can show ground water quality for the point of source, but their construction is time-consuming (Figures 11 and 12).

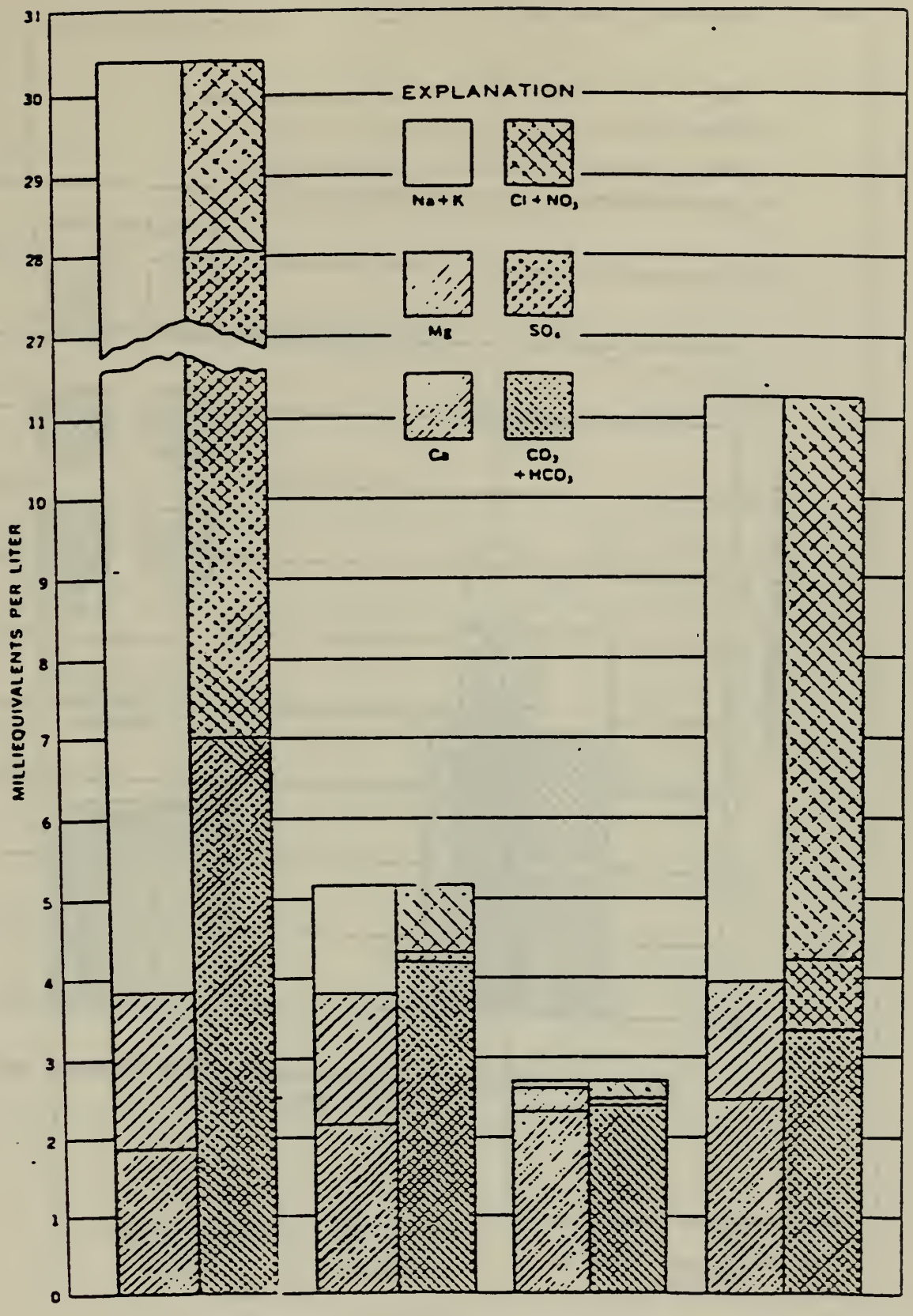

Fig. 3 -Collins ion-concentration diagram(after Hem, 1970)

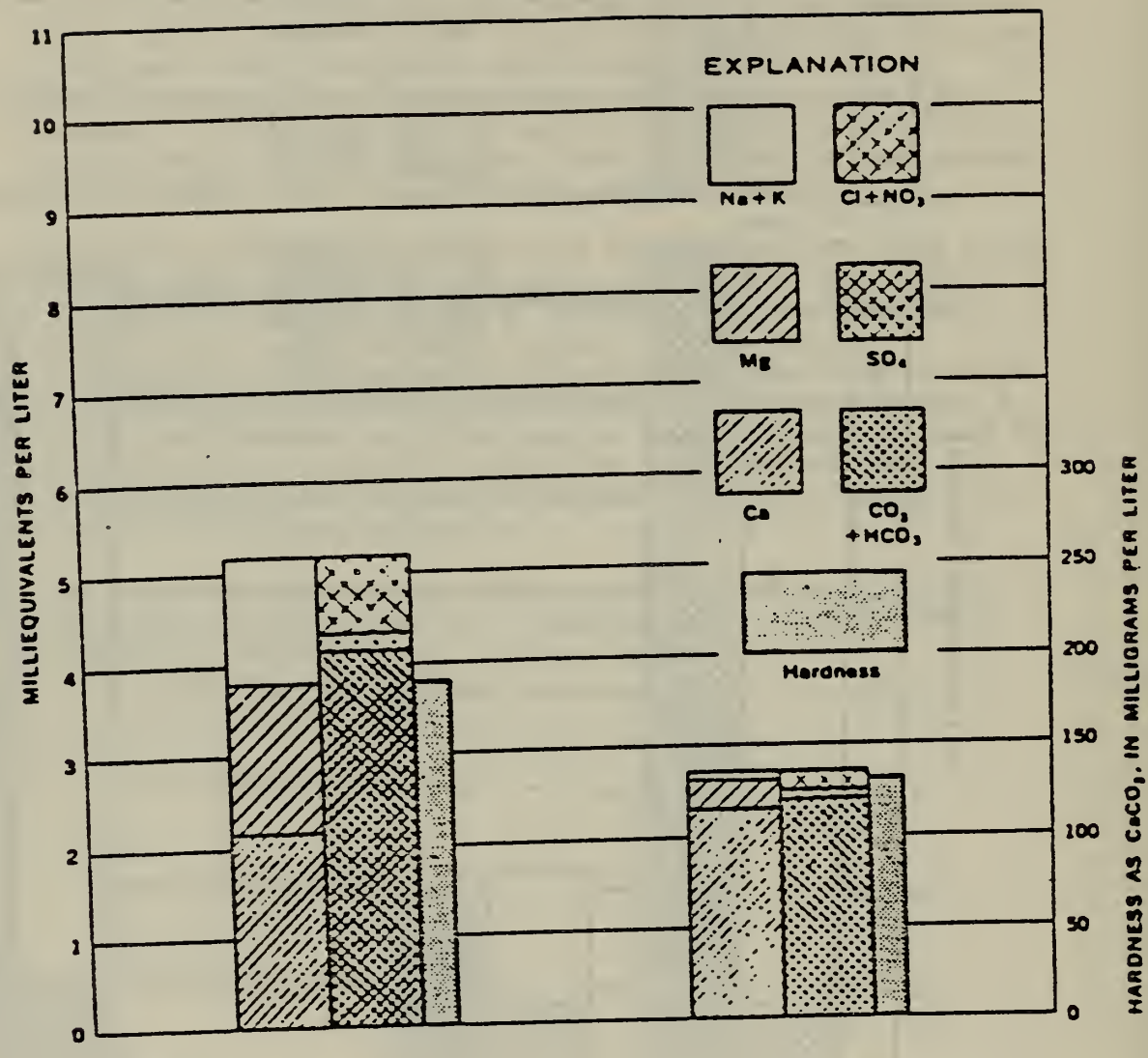

Fig. 4 -Variation of Collins diagram with hardness added (after Hem, 1970)

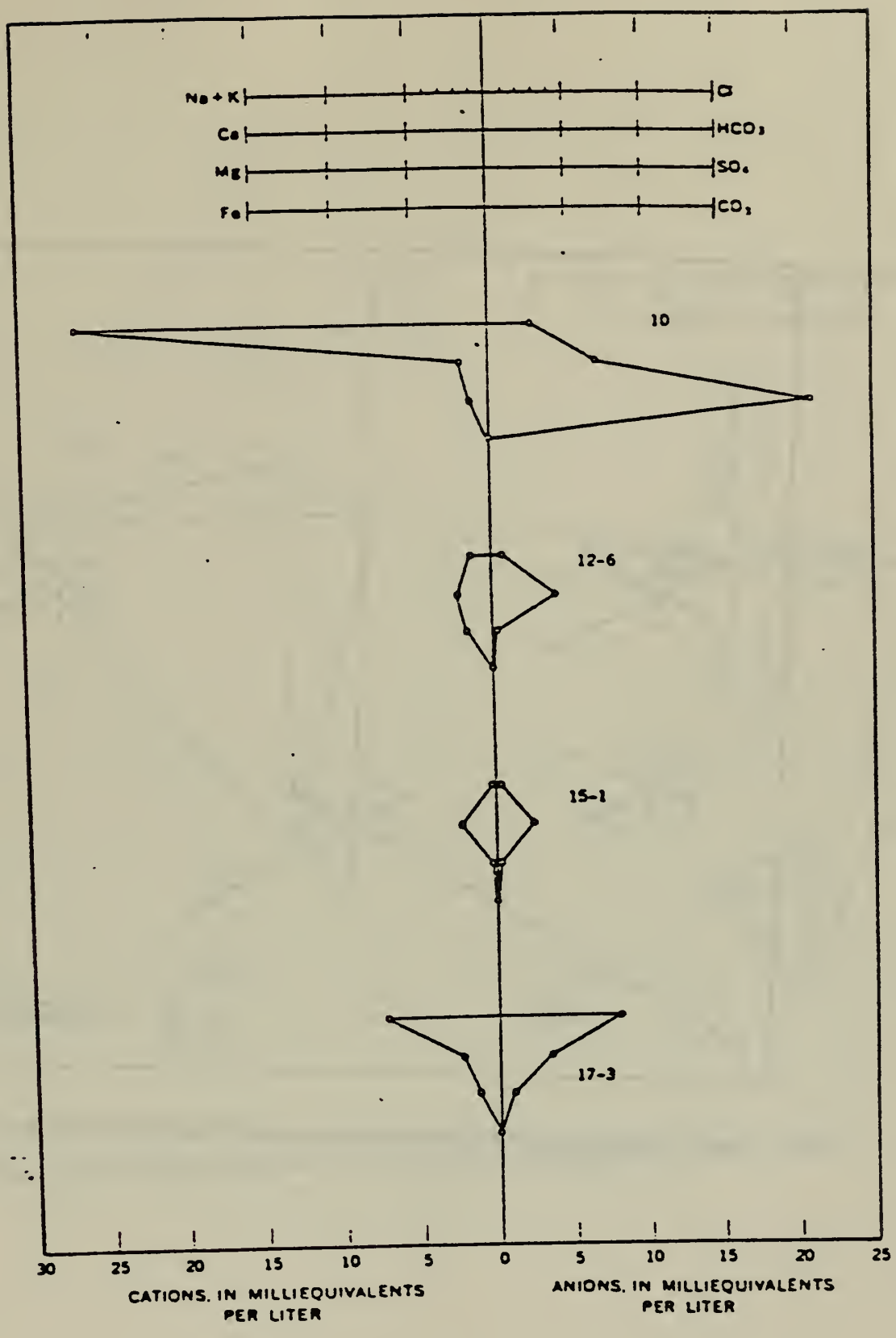

Fig. 5 -Stiff diagram(each shape is a different water source) (after Hem, 1970)

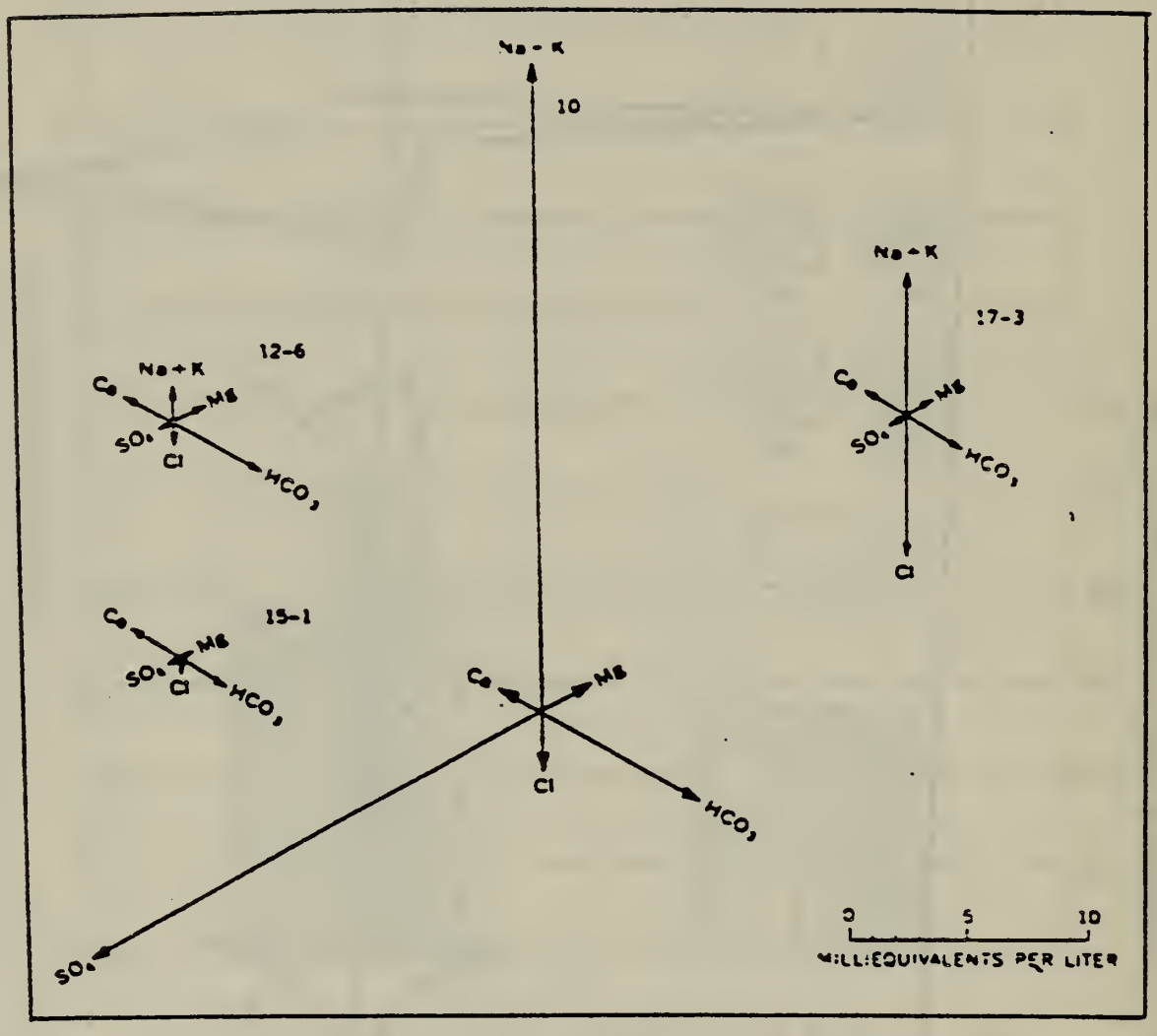

Fig. 6 -Ion-concentration diagram using vectors(after Hem, 1970)

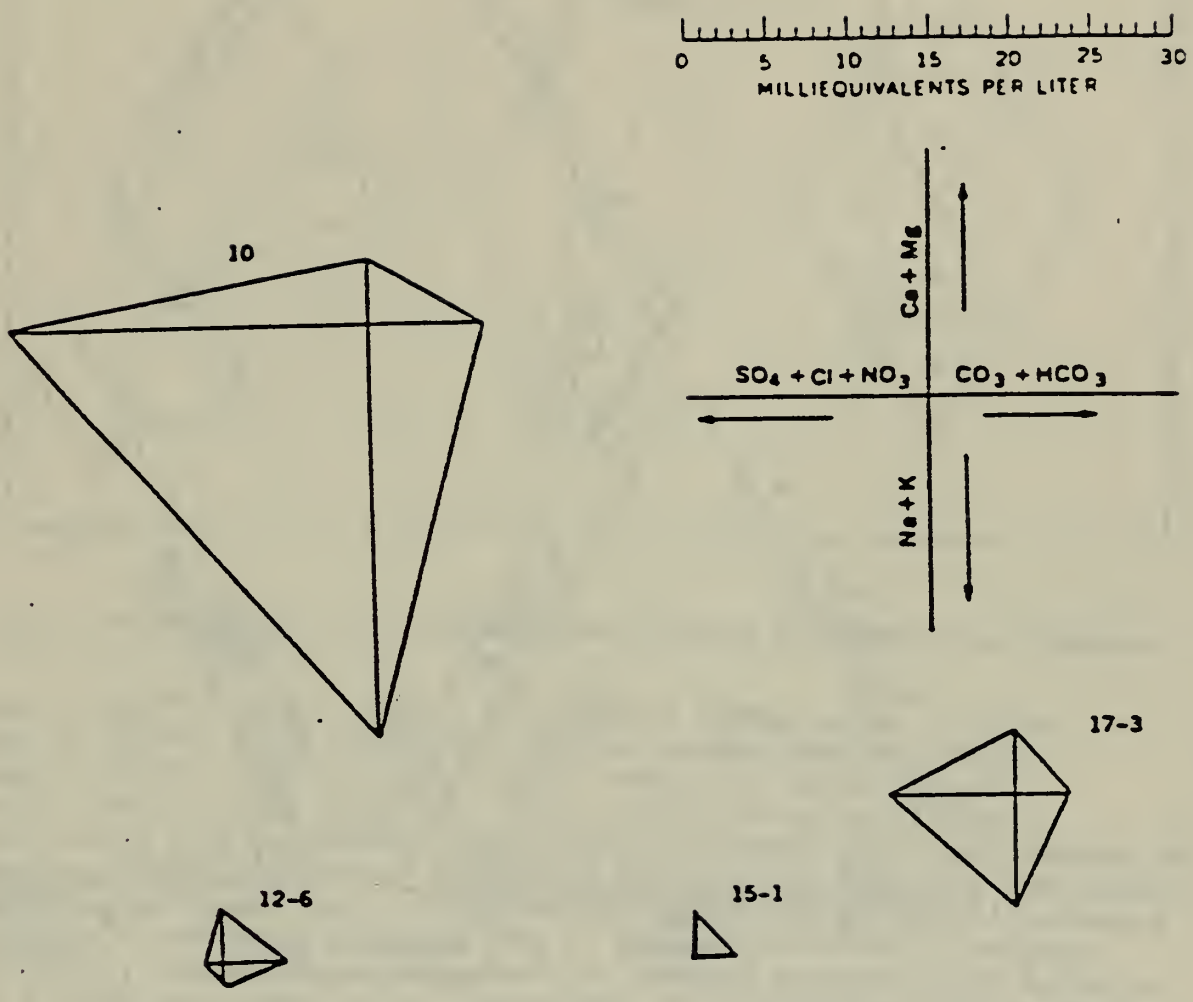

Fig. 7-Four component ion-concentration diagram(after Hem, 1970).

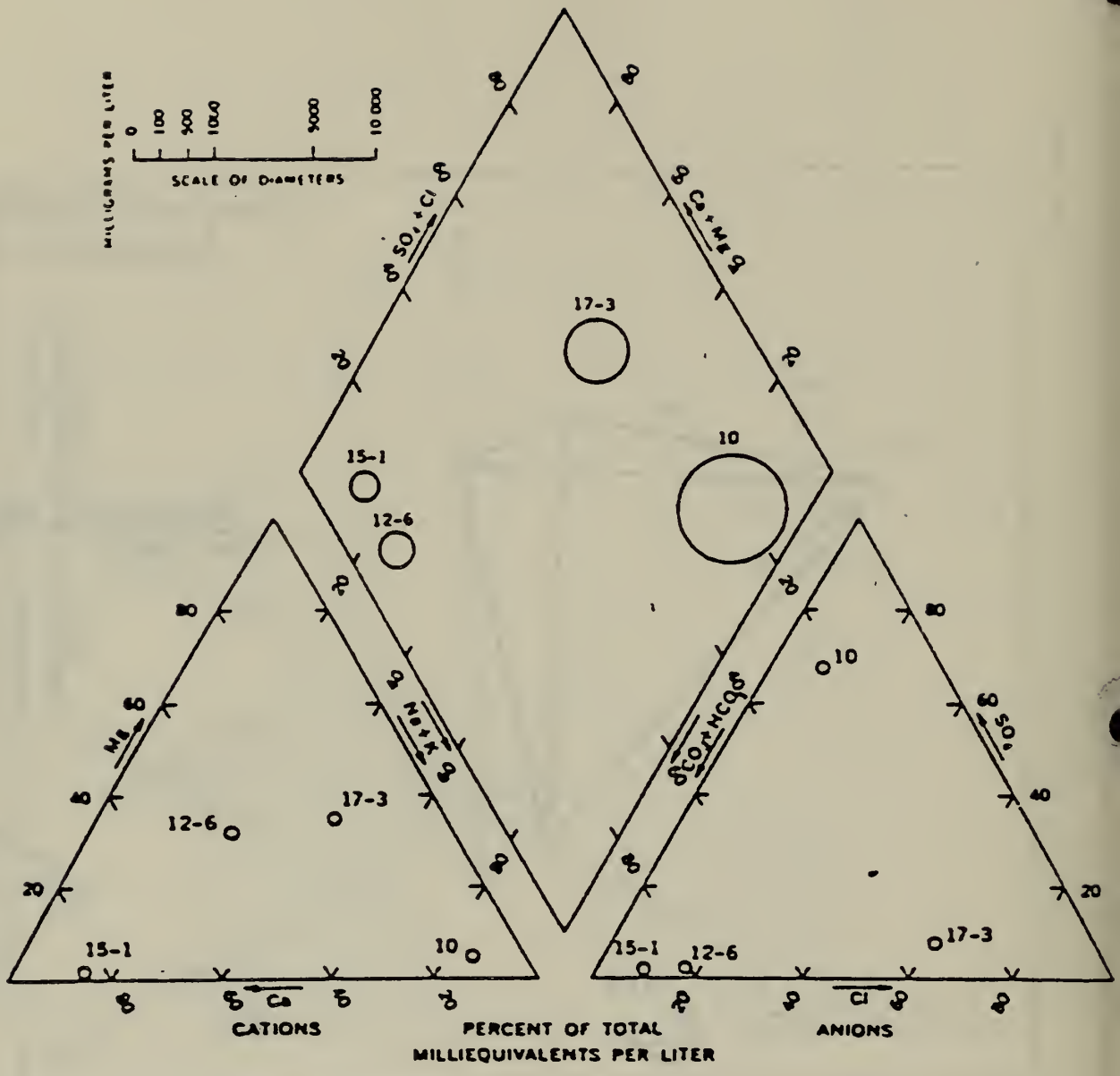

Fig. 8-Piper triliear diagram(the circles plotted in the central field have areas proportional to dissolved solids concentrations and are located by extending the points in the lower triangles to the points of intersection). (after Hem, 1970)

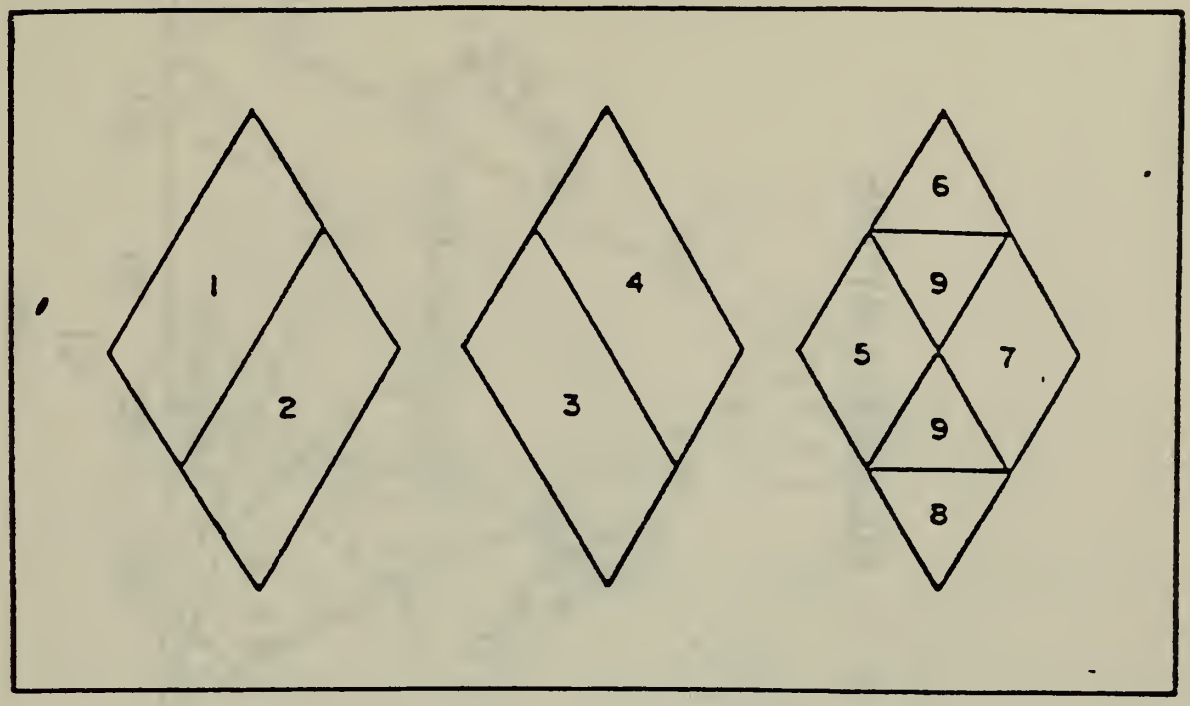

Fig. 9 -Subdivisions of diamond-shaped field of Piper trilinear diagram.

Area 1, $(Ca^{+2} + Mg^{+2}) > (Na^{+} + K^{+})$ alkaline earths exceed alkalies; Area 2, $(Ca^{+2} + Mg^{+2}) < (Na^{+} K^{+})$ alkalies exceed alkaline earths; Area 3, $(HCO_3^{-} + CO_3^{-2}) > (Cl^{-} + SO_4^{-2})$ weak acids exceed strong acids; Area 4, $(HCO_3^{-} + CO_3^{-2}) < (Cl^{-} + SO_4^{-2})$ strong acids exceed weak acids; Area 5, secondary alkalinity ("carbonate hardness") exceeds 50 percent-- that is, chemical properties of the ground water are dominated by alkaline earths and weak acids; Area 6, noncarbonate hardness ("secondary salinity") exceeds 50 percent; Area 7, noncarbonate alkali ("primary salinity") exceeds 50 percent--that is, chemical properties are dominated by alkalies and strong acids; ocean water and many brines plot in this area, near its right-hand vertex; Area 8, carbonate alkali ("primary alkalinity") exceeds 50 percent--here plot the ground waters which are inordinately soft in proportion to their content of dissolved solids; Area 9, no dominant cation-anion pair exists (Walton, 1970).

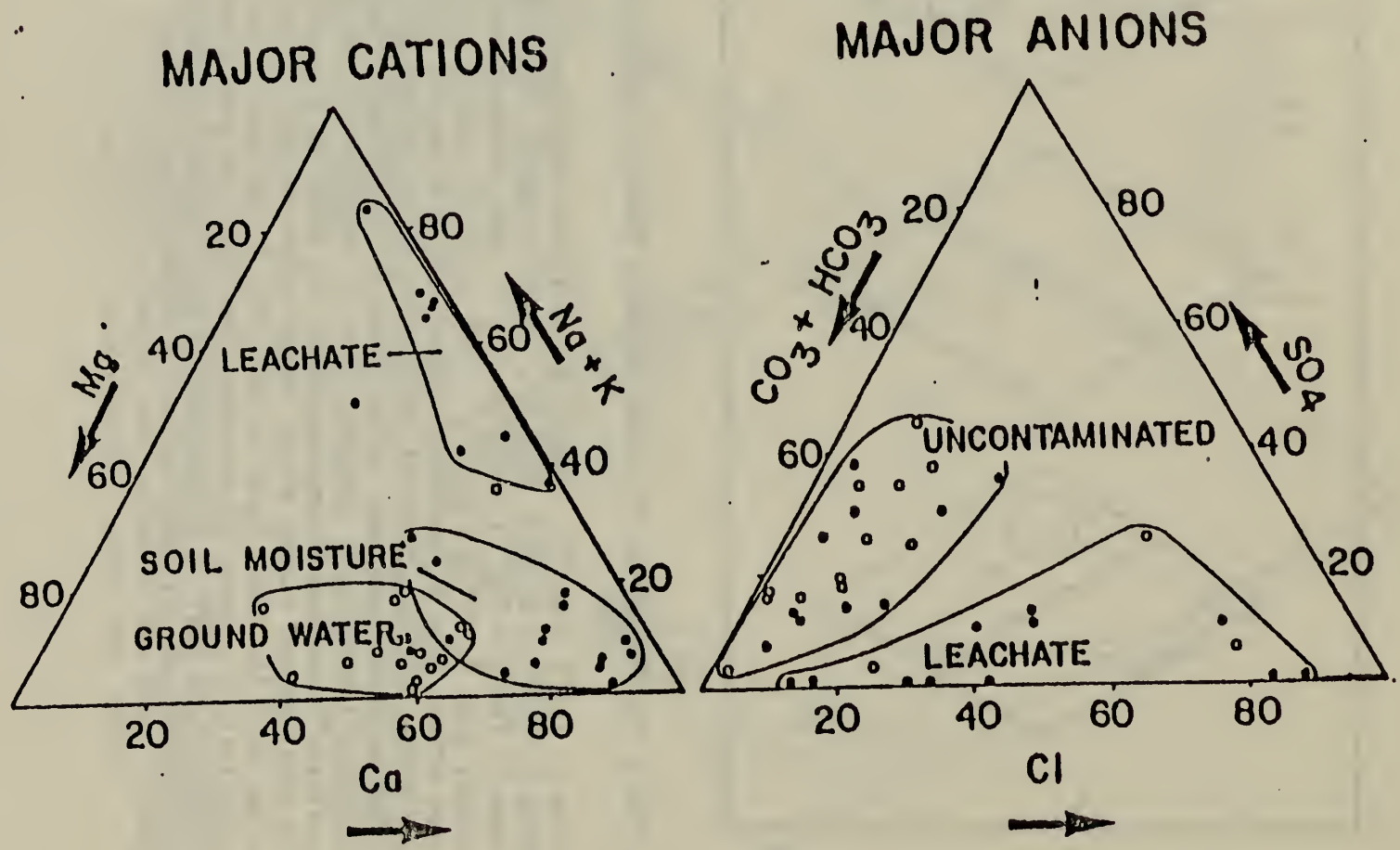

Fig. 10-Use of Piper diagram in water quality interpretations

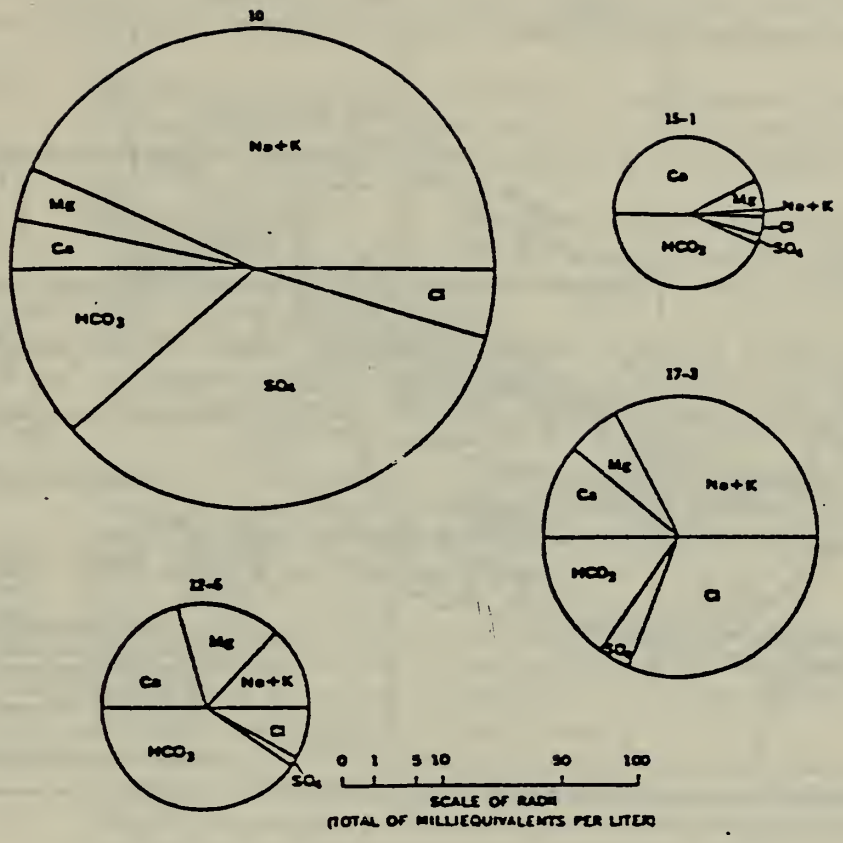

Fig. 11.-Analyses represented by circular diagrams subdivided on the basis of total millequivalents per liter(after Hem, 1970).

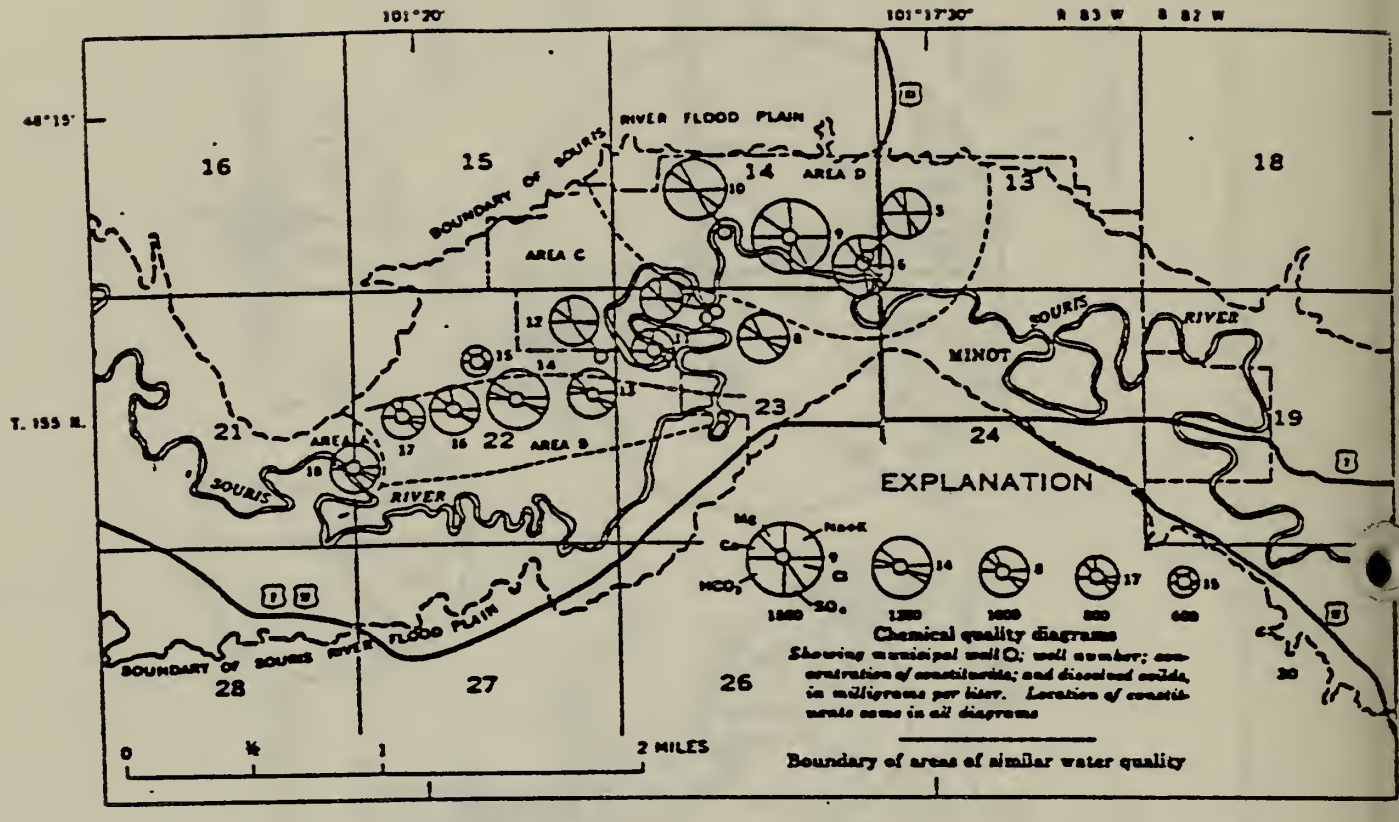

Fig. 12-Example of use of pie chart depiction for water quality on a map(after
1970)

IV. HP-85 MICROCOMPUTER ANALYTICAL GROUND WATER MODELS

(Available from the Division of Resource Systems, Denver Service Center.)

Program 1. General Aquifer Analysis for Nonsteady Theis Conditions - Calculates drawdown at given observation points due to an array of point wells with known pump/recharge rates.

Program 2. Alluvial Valley Floor Analysis - Calculates drawdown at given observation points due to a single well bounded by parallel impermeable or constant head valley walls.

Program 3. Analysis of Source or Sink Flow Rates with Drawdown as Given - Calculates pump rate for an array of wells given a fixed-time drawdown for each well.

Program 4. Steady-state Drawdown Around Finite Line Sinks - Calculates the drawdown at given observation points due to an array of finite line sinks assuming steady-state conditions.

Program 5. Finite Line Sinks for Nonsteady Conditions - Calculates the drawdown at a given observation point from an array of line sinks by integrating the Theis expression for a point along each line with given pump/recharge.

Program 6. Study of Steady-state Flow to Finite Line Sources or Sinks with Drawdown as the Given - Calculates the pumping/recharge rates from an array of lines with a given set of drawdown assuming steady-state conditions.

Program 7. Analysis of Ground Water Mounding Beneath Tailing Ponds - Calculates augmented head above undisturbed water level for a circular tailing pond as a function of time.

Program 8. Mass Transport of Pollutant from a River to a Well - Calculates the concentration as a function of time of pollutant from a river adjacent to a single well.

Program 9. Plume Management Model - Calculates the concentration at a given observation point due to injection of pollutant at a given point as a result of dispersivity/ground water flow.

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(Reference to specific legislative Acts and Executive Orders are not listed here since the full citation exists as section titles in the body of the document.)